Mission Report

on the

Evaluation of Rapid Well Jetting

and the

Canzee Handpump

Programme of MEDAIR in the Regions of

Maroantsetra and Manantenina

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08 August to 22 September 2005

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1. Acknowledgements

The authors are extremely grateful for the assistance provided to this mission from many people, including especially all of the villagers and leaders of the communities that we visited, who were patient in answering our questions and demonstrating their skills and installations. The local authorities in the Maroantsetra area were very welcoming and friendly, and we would like to thank ANGAP for providing a boat for our transport.

Our hosts and visit organisers, MEDAIR and (in Manantenina) BushProof, provided us with all that we could need and were very frank about their experiences.

The Ministry of Energy and Mines was generous in inviting us to use their meeting room for the presentation of our interim results in Antananarivo.

Finally, the evaluation would not have been possible without the financial support of SDC.

Despite the help and assistance of all these people and their willing participation in discussions and other activities, the opinions herein are those of the authors and should not be attributed to those with whom we have talked.

2. Introduction

2.1 Background

MEDAIR has been present in Madagascar since 2002. It runs a development programme in the south-east of the country, as well as operating emergency relief projects in response to need.

- **Development Programme in the Region of Taolagnaro (2002-2006)**

  With a strong focus on water, sanitation and hygiene, Medair started the implementation of a four-year programme in the remote area of Manantenina, north of Taolagnaro*****, in partnership with a local NGO (ASOS).

  The area is severely under-developed and very inaccessible. In terms of sanitation, the majority of the population has no latrines, resulting in gross contamination of the rivers from which drinking water is taken.

  The project trained ASOS water and sanitation technicians as well as hygiene/health promoters. New water points have been constructed together with the villagers, as well as latrines in both schools and individual households.

  Household bio-sand filters have been distributed at a subsidised price. At the same time, hygiene teams work closely with the schools and women, introducing basic health promotion into the curriculum.

  The promotion also included an HIV/AIDS awareness component. Finally, the Medair/ASOS teams provide technical assistance towards grass-roots development-planning initiatives involving the commune authorities.

- **Intervention of MEDAIR after the Tropical Cyclones of 2004**

  A tropical cyclone named “Elita” started in the Mozambique Channel along the coastline of Madagascar with winds estimated of about 100 km/h, before turning southeast and hitting the coastal town of Mahajanga on 29 January 2004. One person was reported killed by the storm and numerous houses and buildings were destroyed in the town.

  MEDAIR conducted a survey and started a small emergency project in Toamasina and Mahajunga provinces. This included helicopter support to the health authorities, provision of food and medicines and improvement of access to clean water.

  On 7 March 2004, the powerful tropical cyclone “Gafilo” struck the northeast coast of Madagascar with strong winds estimated over 200 km/h.

MEDAIR Projects:
1. Manantenina, Toliara Province,
2. Mahajanga, Mahajanga Province,
3. Maraontsetra, Toamasina Province

*Taolagnaro is also known by its colonial name, Fort Dauphin

At least 25 people have been killed in Madagascar and more than 100 are reported missing.

After hitting the northeast coast, Gafilo cut across the northern part of the island moving southwest leaving at least 100,000 people homeless before moving over the waters of the Mozambique Channel.

The cyclone then returned again on 9 March along the southwest coast of Madagascar with less winds and disappeared on 11 March into the western Indian Ocean. Following a rapid assessment, MEDAIR cleaned and disinfected 1,400 shallow wells in the town of Maroantsetra within a matter of days. These wells had all been flooded and severely contaminated.

Maroantsetra is a small port and commercial centre situated on the northeast coast of the island. Its climate is humid tropical, with very high annual rainfall and good production of forest-related crops such as vanilla, spices and coffee.

The many rivers cutting the narrow coastal plain below the mountains mean that it has no permanent road connections to other parts of the island. Local transport is generally by boat or on foot, and long-distance transport by air.

On the surrounding alluvial plains, thousands of people remained marooned in flooded villages for weeks. Here, the team dropped chlorine water disinfectant and buckets by helicopter and boat. As a result, outbreaks of cholera and diarrhoeal disease, which typically followed previous cyclones, were avoided.

During an intensive rehabilitation/mitigation phase, MEDAIR repaired and flood-proofed more than 67 public wells in flood-prone villages and was able to construct 204 new wells, all equipped with Canzee Handpumps, using jetting as a drilling technique. There are now flood-proof water points that ensure a clean supply of water even in the event of future cyclones.

2.2 Methodology of Intervention in Maroantsetra

- **Project Area**

The project was carried out in hydro geologically suitable communities in the rural areas around Maroantsetra. Some installations (not visited by the evaluators) were in the neighbouring District of Antalaha, to the east. The majority were in a number of villages to the southeast, north and west of Maroantsetra town. Installation in the town itself was avoided because of uncertainty over the quality of water, although four pilot installations were carried out to allow water testing.

- **Drilling of Boreholes with the “rapid well jetting” Method in Rural and Semi-rural Areas.**

Shallow boreholes were drilled using a technique known as rapid well jetting, which was new to Madagascar. In this method the quantity of water needed for drilling demands the provision of a small reservoir, dug by hand near the installation point, which is filled with water before drilling begins. A small motorised pump is used to force water from this reservoir along a flexible hose and down a vertical metal jetting pipe. The force of water disturbs the sediment at the base of the pipe, allowing two or three technicians to guide it downwards into the ground. The jetting pipe takes with it a plastic casing pipe, already fitted with a well screen made from perforated PVC pipe wrapped with geotextile. The jetting pipe was used inside this casing, which was provided with a non-return valve at the foot so that water could be forced out but could not return later, bringing sand with it.

(After later problems with sand intrusion to pumps the team also experimented with a closed casing pipe tied to the outside of the jetting pipe – see discussions of results below.)

In Maroantsetra a technical team provided by MEDAIR performed the installation, while villagers assisted with local materials for platform casting and labour for the provision of water and other supplies.

- **Installation of the "Canzee" Handpumps.**

The Canzee pumps were installed following provision of a concrete pump stand around the casing pipe. The installation was performed by the users together with the MEDAIR technical team.

The Canzee is described in detail in Section 4.3. It is a newly developed pump, and although it has previously been installed in some other African countries the MEDAIR Madagascar programme is the first to install it in large numbers.

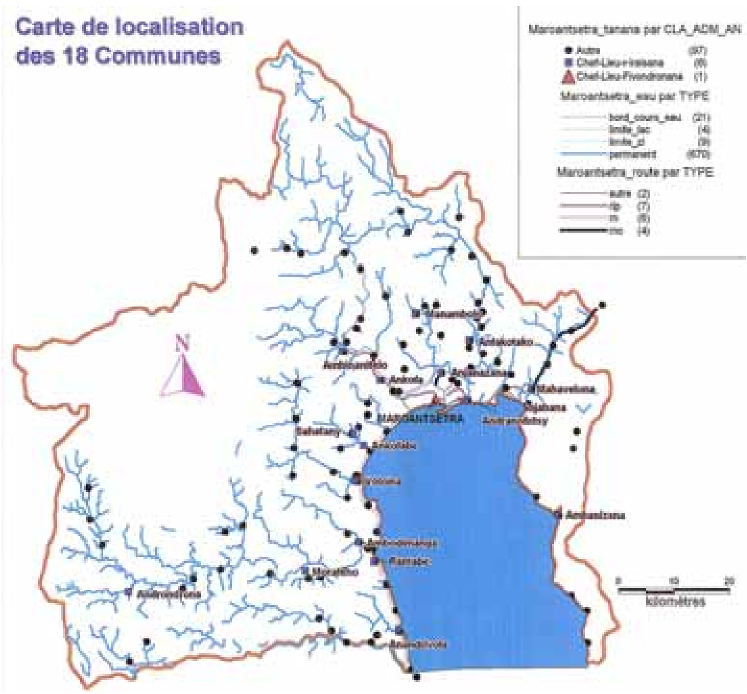
- **Management of Water Points by the User Groups.**

For management of water points, including all operation and maintenance activities, a number of people (usually three) were nominated by users at each site. These people were trained by MEDAIR in simple maintenance and were given simple tools for pump disassembly. MEDAIR suggested that a payment system for maintenance costs should be set up and that users should construct fences to protect their pumps.

- **Funding**

Funding for the programme was provided by the Swiss Development Corporation (SDC) and the European Commission Humanitarian Aid Office (ECHO). This evaluation was funded by SDC.

3. Evaluation Mission



3.1 Objectives

SKAT / RWSN was asked to visit the Maroantsetra Project to evaluate the viability of the new intervention approach, to check the quality and sustainability of the infrastructure in place, to recommend technical improvements of the hardware and to advise on all aspects for social improvements like the management of water points etc.

The Mission was made by two RWSN evaluators between 12 to 22 September 2005.

Prior to the evaluation in Maroantsetra one of the RWSN evaluators made a short visit to Manantenina, to check the performance of those Canzee Pumps that had been installed already in 2003.

3.2 Methods

- During the field visits in Maroantsetra, 74 water points were observed and the quality of work and products analysed (as well as 17 pumps in Manantenina).
- Consultations were held: with pump users, implementers and the local authorities.
- MEDAIR demonstrated its methods and equipments.

The evaluators visited six villages in Maroantsetra District. At these points they analysed the functionality and state of the installation, and interviewed users on the use and maintenance of the handpumps.

In Manantenina District rapid visits were paid to the pumps for inspection purposes, but few interviews were carried out for lack of time.

Demonstration included the installation by the MEDAIR team of two jetted boreholes with pumps, as well as showing the evaluators the work that they had done in the field, their assembly workshop and the adjustments that they had made to techniques and materials to improve the results of their work.

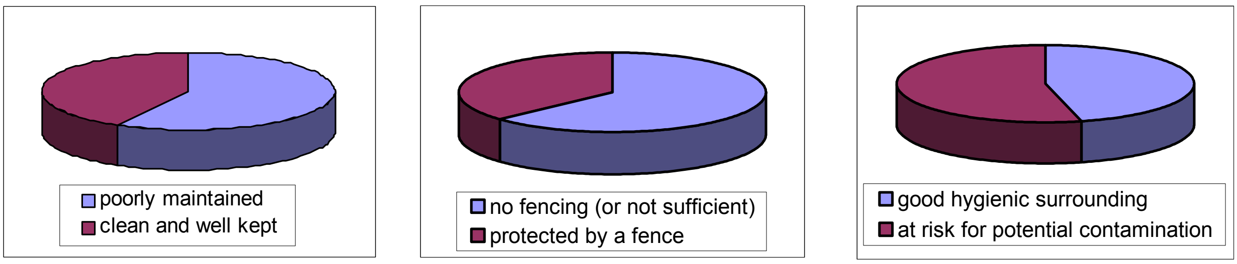
The evaluators also observed MEDAIR staff in taking and analysing water samples for bacteriological quality.

The evaluators also demonstrated some maintenance techniques, as well as a new type of plug to keep sand out of the bottom of the well and the hand-jetting technique for sinking boreholes.

4. Results and Findings

4.1 Environment

Quality of the Well Point Environment



In general, environmental sanitation has not received sufficient attention. Especially in the context of the shallow depth of installation, more careful siting is needed.

Potential contamination sources near to sites included rivers, rice paddies, mangrove swamps, standing water, roads and dense housing, latrines and animals, especially ducks and geese. (Nevertheless, the good quality of the water is described below.)

Most of the pump surroundings in Maroantsetra were not kept clean and there was no means of draining them adequately and no platforms were built around the concrete pump stands. This is different in Manantenina (Fort Dauphin), where Canzee Pumps are placed on Dug-wells and large platforms are provided.

An exception in Maroantsetra is the village of Antoraka, where the fokontany president is very active in following up the management of the pumps, and all those visited were very well kept.

Most wells however were not provided with a fence to keep animals out and prevent children from playing, although some had been well protected, provided with flowers and plants. Some also had roofs constructed to protect them and the users from the weather.

Quality and Quantity of Water Delivered

- 87% provide "sufficient water of good quality", according to the users; 93% used for human consumption.
- Good bacteriological quality (100% of all tests made), although the installation depths of the casing pipes are shallow.
- 19% of user groups noted a smell or a taste from a high concentration of iron.
- Some problems of turbidity (9 pumps) and sand/silt (23 pumps) in Maroantsetra.
- One pump had salty water.

In general a good quantity of water is provided. The average yield of pumps was more than 20 liter/minute and test pumping of demonstration boreholes with the motorized pump showed that ten times that quantity could be pumped from the boreholes at least for short time periods.

The few that had yield problems were the result of installation or pump defects, particularly sand intrusion or misaligned or bent casing pipes.

Bacteriological quality, although a key question in the minds of the evaluators, has so far proved excellent, with no contamination from 12 pumps tested in Maroantsetra, including several from urban areas.

It remains to be seen whether this will persist for many years, or whether contamination will begin to occur after a certain time period.

Therefore a continued testing programme is required. It is clear that the sandy strata in the project areas currently provide an effective filter, removing contamination before it reaches the water table.

SKAT believes that urban areas such as Maroantsetra itself should not be served by shallow installations such as these. The contamination of the water table at Toamasina has been demonstrated by testing, for example by WaterAid. Similar geological conditions suggest that similar problems are likely to occur as Maroantsetra develops (see also text box).

In some villages, iron concentrations are high (up to 8 mg/lt, reported by MEDAIR) and this is preventing the use of a number of pumps. Most of those with severe problems have been reinstalled by MEDAIR at a shallower depth.

This has provided access to more oxygenated aquifers that have lower iron concentrations. However it may exacerbate concerns over bacteriological quality.

The inside of a few pumps were covered with a red layer, which can be removed by rubbing. Although it appears like an oxidation problem,

> The authors note that, in the short term, the installation of shallow boreholes in Maroantsetra would provide better quality water than the existing open wells.
>
> However, because of the longer-term dangers of bacteriological and nitrate contamination of the shallow aquifer by human waste, we cannot recommend it in isolation.
>
> Rather, SKAT would suggest that the Commune and the Ministry of Energy and Mines should draw up a plan for the development of water supply in Maroantsetra. According to the timescales and budgets available, plans might include deeper boreholes with handpumps, boreholes with electric pumps and simple distribution systems or shallow groundwater with treatment.

the drawn water is clear and has no taste and no smell of iron.

MEDAIR has sent water samples of those pumps to a laboratory in Tana for getting clarification of this phenomenon. However, the laboratory confirmed that the water quality is fine, but they could not give a reason for the red layer, other than a possible growth of bacteria. Further investigations will be required.

Sand intrusion as a result of technical problems with the jetting valves has also caused a number of pump failures. Several of these have also been reinstalled, using a different technique by which the jetting pipe is attached to the installed casing, rather than being inside it (see also Recommendations 6.1 Rapid Well Jetting).

Turbidity is not a common problem, since clean aquifers have been found in most of the areas where installation has been done. A few wells have a small silty or clayey content in the water, but this is not causing major problems.

One borehole about 100 m from the shore has somewhat salty water, but the quality is within national standards.

4.2 Rapid Well Jetting

The "jetting"

- The "rapid" method is effective in the suitable layers.
- Difficulties faced to penetrate permeable or harder layers.
- Difficulties faced to penetrate the ground beyond 6 to 7 meters.
- More experimentation is required with the valve of the jetting shoe, the power of the jetting pump and sealing plug (technique for sealing un-tight jetting shoes).
- Hand jetting (sludging method).

Well Casings

- In general, the casing pipes have been installed properly.
- Problems detected with casings include non-verticality of installations and sand intrusion at the jetting shoe (or because of displaced geo-textile filter).

MEDAIR has shown that jetting is a very rapid and effective methodology within its limitations, resulting in quick installation of many wells, providing water to large numbers of people in a short time and with good probability of sustaining the installations.

As had been identified by MEDAIR, the coastal plain in the Maroantsetra area is hydro geologically suited to the method, because it consists of a quantity of unconsolidated and often sandy sediments (thickness unknown), with a water table that varies between ground level and about 4 m below ground.

In ideal conditions part of the jetted water forces its way downwards, allowing the pipe to penetrate. Another part flows back upwards, around the outside of the jetting pipe. This water keeps the sediment from closing again around the pipe and jamming it.

Limitations include the difficulty of jetting through coarse sand and fine gravel formations, which are found in some areas. In these layers the force of the jetting water is lost because of the quantity that disperses into the formation. When this happens the water flow up the outside of the pipe is lost and the sediment jams the pipe in the hole.

Hard clayey sand layers are also difficult to penetrate, according to the MEDAIR technicians. This is presumably because the jet of water is not strong enough to disturb a cohesive sediment.

Even in favourable formations the technique has only been able to deepen wells to 7 or 8 m below ground, and to 4 or 5 m below the water table.

Problems with sand intrusion have caused a significant number of pump failures. Sand may enter the borehole casing either through the well screen, if the outer wrapping of geotextile has slipped, or through the jetting shoe at the bottom of the casing if this fails to close properly.

To deal with the first problem the MEDAIR team now routinely wraps several layers of geotextile around the screen. Nevertheless these may become displaced if it is necessary to force the casing into the ground.

The second problem appears to be the major one, however. The jetting shoe is closed by a simple ball valve, relying on the weight of the ball to close the base of the casing.

It appears that this sometimes fails following installation, and that sand is able to push through the valve from the bottom. Bearing in mind that the boreholes are cleaned immediately after installation by pumping at very high flow rates, using the motorised pump, it is perhaps not surprising that some of the valves open again and allow sand ingress.

It is also quite possible that suction forces caused by rapid hand pumping using the Canzee Pump are sufficient to displace the ball slightly – enough for a few grains of sand to prevent it from closing properly again.

To deal with sand intrusion, MEDAIR technicians developed a variation of the jetting method, using the jetting pipe outside the casing, which can therefore be sealed at the bottom before it is sunk.

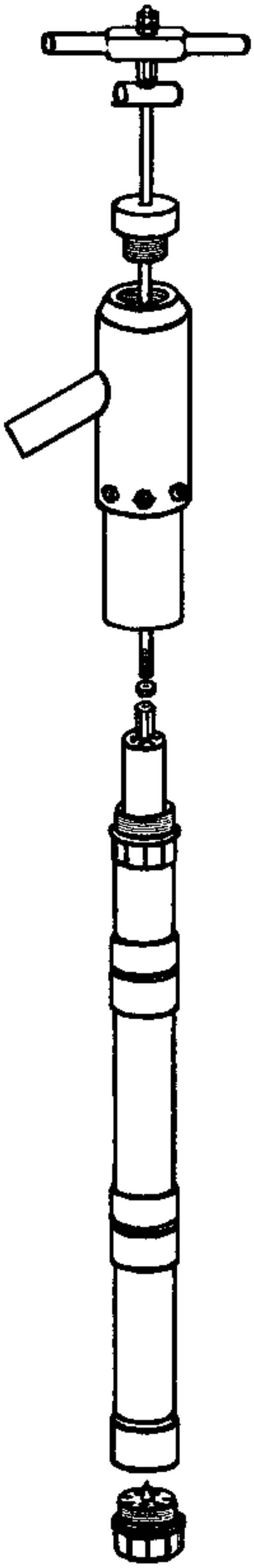
However, this method appears to have resulted in other problems. Because the two pipes go down in parallel, the required hole is much larger, and it is even more difficult to get to depth or to penetrate harder formations. Also, the lack of a rigid jetting pipe inside the plastic casing has allowed the casing to flex during installation, especially when vertical force is applied to attempt to sink it to a sufficient depth. The result is that the pipes installed inside the casing are not straight, and rub together when pumping, making the action heavy and increasing the danger of breakdowns.

Most of the pumps with observed problems due to the non-verticality of pipes (see below) were fitted on boreholes installed in this way.

More experimentation is therefore needed to overcome these problems (see also Recommendations 6.1 Rapid Well Jetting).

4.3 The Canzee Pump

The Canzee Handpump is a water-lifting device, by which the pumping action is articulated directly to the pumprod and plunger. These pump types are named according
to their operation Direct Action Pumps (DAP).



The advantage of the DAPs are:

- Fast and easy installation,
- Easy operation, also for smaller children,
- Maintenance for users not difficult,
- Relatively large discharge (20 to 30 lt/min.)
- Affordable price.

The dis-advantage of DAPs:

- Maximal water lifting capacity is 12 to 15 m,
- Most of DAP's are designed as family pumps for serving user groups of about 100 to 150 people.

- **Technical Features:**

  First developments for this DAP were made in New Zealand, later on improved and refined by Richard Cansdale, SWS Filtration, England.

  The Canzee Pump is totally corrosion resistant because all materials used are either of plastic, wood or stainless steel.

  The **above ground components**
  like pump head and pump body are very rigid and are designed as such that dismantling is easy for the users. The material of the pump body is made of ABS, a material that is protected against Ultra violet rays from the sun light (UV-resistant).

  The **down hole components** like rising main and pumprod pipes are made of standard PVC-U pipes used for drinking water and the plunger and footvalves are machined from Polyamide.

  The only non-plastic components are the pumprod (stainless steel) the pump handle (local hardwood) and a number of bolts, nuts and washers (galvanized steel), which are not in direct contact with the water pumped.

- **Manufacturing:**

  The Canzee Pump has been designed so that the majority of plastic materials used are readily available on the market and only few machining operations are needed for finishing the single pump components. Therefore simple manufacturing equipment is required (small lathe machine and a number of tools and fixtures).

- **Assembling:**

  For assembling complete pumps, minimal tools and connecting fixture are required for jointing the plastic components by gluing (ABS) and solvent cementing (PVC-U components).

- **Local Production:**

  This design allows that this pump type has an excellent chance to be locally produced *, provided some minor adjustments would be made to the availability of materials in Madagascar.

  The biggest advantage of locally produced components is that they would ease the problem of the availability of spare parts and would be a good base for a functioning supply chain.

  Besides providing job opportunities for many artisans, locally produced pumps and spare parts would be considerably lower in price than the presently imported ones.

- **Transport:**

  Due to the fact that the Canzee Pump is made of plastic material, the total weight for a pump installation with a cylinder setting of 8 m is only 15 kg. The jetting equipment is also easy to transport (petrol engine with pump = 24 kg, flexi-hose of 15 m length = 15 kg, 4 m jetting pipe of Aluminium = 15 kg plus fuel).

  This is a big advantage, especially if the pump and the jetting equipment needs to be carried to remote places (by pirogue or by hand).

- **Installation in Borehole:**

  Besides the “light weight equipment” for well jetting (petrol pump, fuel and jetting pipes), two bags of cement are required to make a proper pump stand with platform and drainage channel.** Gravel and sand are in most places available.

  After the borehole has been jetted and developed (pumped until water is clear), a water sample is drawn for general testing of the water quality. The casing pipe is then tightly closed and the pump stand with platform and drainage channel has to be made. After a curing time of 3 to 5 days, the Canzee pump can be installed.

  The installation includes solvent cementing of rising main pipes and pumprod pipes in the required lengths and the holes for fastening the pump head have to be made (see MEDAIR instructions). The installation time for a cylinder setting of 5 m requires approximately 30 minutes to 1 hour.

- **Installation in Existing Dug-wells:**

  The construction of a dug-well cover with a pump stand, a manhole with a manhole cover is essential for sealing dug-wells from contamination.

***** BushProof together with SWS Filtration have joined to set-up a workshop in Tananarivo to start local production of Canzee Pumps, starting November 2005.

****** According to BushProof, a new version of a platform has been developed that includes a slab with drainage and can be constructed with only one bag of cement.

Special care has to be taken to disinfect the existing dug-well, before a handpump is installed.

The procedure for installing the Canzee Pump on a dug-well is similar to the installation in a borehole (see MEDAIR instructions).

Please note that for deep cylinder settings (12 - 14 m), the riser pipes should be fixed to the well lining, in order to avoid swinging of the rising main during operation of the pump.

- **Maintenance of Canzee Pumps:**

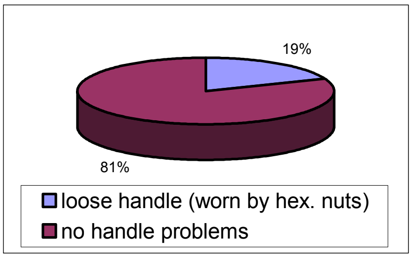
  The Canzee Pump is designed so that maintenance is very easy and understandable for the pump users.

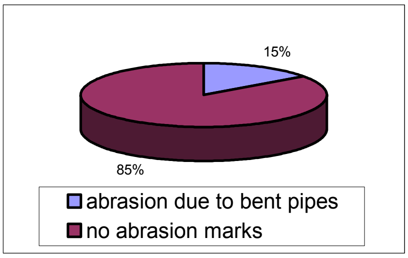
  Only one spanner and one nail are required to dismantle the whole pump.

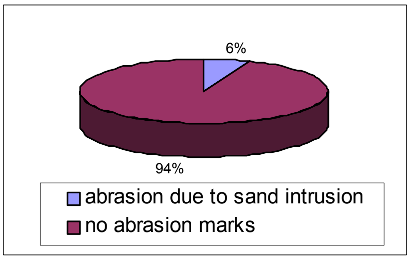
  The down hole components can be cleaned, checked and re-installed in a short time (10 to 20 minutes) and little force for lifting and tightening is required.

- **Problems Detected during the Evaluation Mission:**

  During our survey we found the following main handpump problems:







Other single problems:

Three pumps were found with a broken pumprod (at the threaded portion); it is not clear whether additional bending stress due to one-handed pumping is causing this problem.

Broken pumprod

3 pumps had problems with slipped pumprod and riser pipes due to poorly solvent cemented joints.

Bad pipe joint

Bent pumprod

2 pumps had a bent handle rod due to vandalism.

Movement restriction

At many pumps users had installed a self-made stop for the pump handle, to prevent the pumprod pipe from hitting the pumprod guide at its upper-most position. The limitation of the handle movement was made with a small rope.

Long pumprod cleverly solved by the community by attaching several rubber discs made from car tyres.

3 pumps were found with pumprod pipes that were too long, so that the plunger at end of the down stroke was hitting the footvalve (installation problem).

Worn hex nut

Lower hex nut totally worn; it has slipped below the pumprod thread.

Handle problem solved by attaching a wooden washer.

Wooden washer

4.4 Costs

- **Investments (for the Programme and the Beneficiaries)**

  MEDAIR has evaluated its costs for the Maroantsetra installations. According to the National Director, Christophe Roduit, pump purchase including transport costs from England to Maroantsetra, administrative support and installation, their total investment is around 700 Euro = 1'750'000 Ariary per pump installed in Maroantsetra (this price includes the pump cost of 310 Euro and the extra cost for the larger apron).

  The pump users contributed with delivering of materials (gravel and sand) and provided labour. Because of the emergency nature of the project and the rapid and simple installation methods used, the beneficiary contribution was small in financial terms.

- **Maintenance**

  At present maintenance costs are very low. Some of the repairs have cost a few thousand Ariary (a few Euro): e.g. for the purchase of solvent cement for repairing slipped pipe connections. Smaller amounts have been used at a few sites for replacement of the pump handle (local production). Other maintenance, such as provision of rope to stop excessive handle movement and the washing of down hole components, has been carried out by the users at no cash cost.

  One should not, however, assume that maintenance costs would continue to be so low. As mentioned above, the MEDAIR Madagascar programme is the first to use the Canzee Pump on a large scale, and its long-term performance in the field must be evaluated over the coming years. Further comments on sustainability are set out below.

4.5 Capacity for Achieving Sustainability

Capacity of MEDAIR

It is clear that the MEDAIR team in Maroantsetra is very capable. The intensive installation programme following the cyclones built strong technical capacity very quickly, and the evaluators were interested to see that not only were the technicians proficient in the standard installation but were also willing to experiment with both the jetting technique and the pump assembly methods.

This reflects well on MEDAIR as an organisation and on the technicians as individuals.

MEDAIR has set up a small workshop in Maroantsetra, equipped with a small lathe and other simple tools. Here they have the capacity to assemble pump components and to manufacture small quantities of pump rod connectors, footvalves, etc.

Logistically the programme also performed well, achieving large numbers of wells installed in a short time period and thus demonstrating the potential of the method and the pump for widespread and rapid installation in appropriate conditions.

The MEDAIR team is not very familiar with other alternatives for water supply such as spring protection, gravity-fed systems and other methods for making boreholes, although staff has recently been on exchange visits to see the work of other organisations using different techniques and equipment. (Technical expertise in these fields could be sought from BushProof Madagascar.)

Capacity of the Community (technician, pump committee and users).

Because of the rapid nature of the evaluation, it was not possible to assess community capacity in great detail. However, informal interviews with users and committee members were held at many of the pumps that were visited.

Organizational issues are discussed below, but the level of knowledge within the community groups appears to vary considerably. At many sites some of the users could explain or demonstrate how to disassemble the pump, or explained that they had already done this for maintenance. Small repairs and cleaning of pump had often been carried out. At other sites, however, users told us that there had been no maintenance intervention at all, and at a number we could not find anyone with knowledge of disassembly.

The evaluation did not assess community participation in the Manantenina programme. However, MEDAIR staff said that there appeared to be greater difficulty in organizing community maintenance in that area. One advantage in Maroantsetra is that most of the pumps are installed in areas of relatively dense housing, so that at least four or five pumps can be found within a small area. This means that, in the event of a problem that they cannot resolve, there is often another user group nearby that can help. The evaluators found instances of this, where committee members from one pump had been called in to assist those at another pump.

User groups have already fabricated replacements for certain important components in some cases. These include pump handles and rubber flap valves. The evaluators noted, however, that community members had not been trained in solvent cementing of PVC pipe joints. This is an important skill that should be included in future.

Financial capacity for maintenance within the community was not evaluated. MEDAIR encouraged users to collect regular contributions and form a maintenance fund, but we found only one village that a small amount of money was collected. Users prefer to raise money on a one-off basis when required. This can be expected to work reasonably well for small expenses, but will become problematic when larger amounts are needed.

Number of Users

Sustainability may be affected for some pumps by the large number of users. The Canzee Pump was designed for medium-sized user groups of up to 100 people.

In Maroantsetra sites were chosen by user groups after MEDAIR allocated a certain number of pumps to each village. The distribution within the villages was therefore determined by the village leaders. We found some pumps that served as few as three households. There may be good reasons for this (such as the distance of a small group of houses from the main village), but it appeared to contradict MEDAIR's general rule of about 15 households (approximately 90 people) per pump.

The evaluation also recorded eleven pumps with more than 200 users, and 50% had more than the recommended number of 100.

There does not currently appear to be any clear correlation between the pumps with large user numbers and maintenance problems, but this can be expected to develop over time as the pumps become worn. It would be interesting to evaluate this in more detail in two or three years' time.

Availability of External Support (spare parts and technical support)

The lack of long-term external support available to user groups is a very important missing link in ensuring the sustainability of the installations.

Although inter-group support provides technical support, this is limited to the capacity of the best user groups in the community. For external technical support communities are still almost completely reliant on MEDAIR, although ANGAP does limited follow-up. MEDAIR staff still visits the installations from time to time and have been able to provide free assistance and advice in many cases.

However, MEDAIR has no permanent presence in Maroantsetra, and to date it has built no alternative local capacity. These institutional matters are further discussed in section 4.7.

Effective external support also includes the provision of spare parts. There is no established spare parts supply up to date, and although as mentioned above some spares have been locally made by MEDAIR this is not currently sustainable. For some parts (e.g. pump heads and handle rod bushes) there is no possibility of local production at present because they are made from materials that are not locally available in Madagascar (e.g. ABS plastic). These must therefore be imported from the UK.

However, the whole sustainability issue might be improved soon, since BushProof with the help of SWS Filtration will open a workshop in Tananarivo where Canzee Pumps and spare parts will be produced locally.

4.6 Engagement of the Users

Communities Participation in the Project

During construction, Maroantsetra communities provided relatively small amounts of labour and local materials. The requirements were small partly because the techniques are simple and economical, and partly because of the emergency nature of the programme.

In Manantenina more participation was required from communities, because considerable amounts of labour are needed for well digging, and much larger quantities of sand and gravel for the concrete well lining and cover slab.

The relative complexity of the construction process, as well as the different nature of the programme in Manantenina (longer-term development rather than rapid relief) dictated different approaches from MEDAIR to the communities. Staff told us that the work in Manantenina involved much more time input from MEDAIR staff in organizing and working with communities to plan and build capacity. In Maroantsetra rapid preparation work was carried out by staff from MEDAIR’s local partner, ANGAP (the National Agency for the Management of Protected Areas). ANGAP assisted with community mobilization and information through their existing team of community workers.

Interestingly, there seems to be no great difference in the enthusiasm and capacity shown by users for the operation and maintenance of pumps between the different areas. The reasons for this difference are not clear. They may stem partly from the different socio-cultural background of the two areas, communities in Manantenina being comparatively more isolated and less used to working with outside organisations. There may have been deficiencies in the social approaches used in Manantenina, but this was outside the scope of the evaluation.

In some parts of Maroantsetra community groups are well organized and capable of carrying out the necessary repairs. In others they are hesitant to disassemble pumps and do not know how to use the tools that were provided. Committees that were set up by the project often do not appear to be functional. Although in most cases people know who the committee members are, a single person often does any maintenance: the landowner of the pump site or the person entrusted with the tools.

It appears that insufficient support was given at least in some cases. If similar techniques are to be used in a development context (rather than relief) additional, possibly follow-up, training should be included.

There is a need for much more developed social promotion, especially with regard to environmental sanitation and hygiene. Because this was an emergency response it is not surprising in Maroantsetra that the time-consuming social promotion was lacking, but the project should do further work on helping communities to site wells away from pollution sources, and on ensuring that they protect the installations and keep them clean. Particularly in areas of relatively dense population, exchange visits between communities that are well organized and those that fail to maintain their pump environments can be useful in encouraging better operational practices. MEDAIR could also learn from the approaches and tools developed by other NGOs working in the water and sanitation sector in Madagascar.

Water Use

As mentioned above, users reported that 93% of the pumps visited were currently used for drinking water.

The use of water depends on the users' perceptions of quality; in general the pumps are clearly well used, and the water is well accepted for consumption. Typical consumption figures provided by users (though not verified by the evaluators) were between 7 and 15 liters per person per day. This figure is quite low considering that people in the rainforest environment of Maroantsetra bathe frequently. It may be that it reflects the use of other water sources, discussed below.

Certain pumps that provide water with a high concentration of iron and/or manganese are not used for drinking because of the unpleasant smell and/or taste of the water. Water with a slightly lower concentration of these metals is quite commonly avoided for washing clothes and cooking because of the black or red coloration that it gives to food and cloth.

The use of unprotected dug-wells is continuing in various villages, particularly where there is high population pressure and many users per pump (e.g. Mahalevona). Some of the time these wells are used only for washing, but the evaluators also observed people taking water for drinking and cooking.

Many pump users continue to use nearby rivers for bathing and washing, even if they use the pumps for drinking and cooking. However, in areas where there is no convenient access to rivers, the pumps are used for all purposes. This includes watering domestic animals.

Hygiene messages related to the use of water from different sources for specific purposes have not been developed.

Red layer (no iron)

Red layer (no iron)

Red staining (iron)

Summary Assessment of Installations

- Installations are well accepted by communities and well used. In some communities people continue to use other sources, including especially open wells and rivers.
- We were not able to establish how many people were not using the Canzee Pumps at all, but many are using other sources for some uses, particularly bathing and washing clothes.
- People find the pumps easy to use and they have no difficulty in getting as much water as they want.
- The quantity of water used was not studied in detail during this evaluation, but users told us that they typically take between 7 and 15 liters per person per day from the pumps, which is relatively low considering that people on the east coast bathe frequently.
- Use is affected by the iron concentration in the water, and some pumps are not used or are used only for bathing for this reason.

Removal of of iron and/or manganese in drinking water:

When water is stored for a day in safe conditions, more than 50% of most bacteria die. Buckets used for storage are ideal, because the water can be secured against re-contamination with a cover and a bucket is easy to be cleaned.

During storage, the suspended solids and some of the pathogens will settle to the bottom of the bucket. For better settling results, the raw water can be filled in a jerrycan (only half-full) or any smaller container with a watertight cap. Rapid shaking of the container for about 5 minutes (aeration) has the effect that water is brought into close contact with oxygen. Dissolved minerals such as iron and manganese are oxidized and will settle to the ground during storage. Also substances that affect taste and odour (hydrogen sulphide and methane) can be removed with this procedure. The content of the jerrycan needs than to be poured into the bucket for the settling process.

Recommended storage time for the settling process is 24 hours wherever possible. However, longer periods of storage will lead to a better water quality.

After storage, the water needs to be filtered with a clean cloth or better a household sand filter.

4.7 Institutional Aspects

Government Policy

Government policy in the water sector is favorable to the work of NGOs and particularly to community participation and leadership of the process of water supply development. These principles are written into the Water Law (Code de l'Eau) and the draft Procedures Manual for water and sanitation.

The Canzee Pump has also been accepted by government, and is included in the Procedures Manual as one of the standard handpumps to be used in Madagascar, despite the relatively short experience of working with it.

Integration of Authorities

At the national level the Ministry of Energy and Mines (MEM) and the National Security Committee (CNS) were involved in planning the relief effort.

Local government structures include the Maroantsetra District (based in the town of Maroantsetra), the Communes (all of which are rural communes except for Maroantsetra itself) and the Fokontany (wards).

The Communes and Wards were well integrated in the process of planning and implementing. They were MEDAIR and ANGAP's main partners in providing information to local communities, ensuring the participation of users in provision of local materials and labour, and supporting efforts to set up suitable maintenance arrangements.

The District office was not significantly involved in planning or implementation, and has not since taken part in any follow-up activities.

Support Institutions

As mentioned in Section 4.5, MEDAIR is the only institution in Maroantsetra with technical capacity for the maintenance of pumps and boreholes. Because it is the field office of an international NGO, its presence in the District is of course not permanent.

The local authorities and ANGAP could continue to assist with the organisation of the communities, but have no technical capacity. In discussion with the mayors of the various Communes in Maroantsetra the mayors suggested that the local Association of Mayors of Maroantsetra might be able to play a role as a support institution.

To date MEDAIR has not had the resources to engage these local actors more effectively in working out a long-term strategy for sustainability of the installations. This may be because the emergency nature of the intervention made such planning difficult to develop during the course of the project.

5. Conclusions

5.1 Performance of Installations

- Good performance. They provide water in quantity sufficient for their users in almost all cases (although the number of users is higher than recommended at many pumps).
- Some boreholes have installation defects and have not performed as expected.
- Some defects have been rectified, but methodologies need to be reviewed further to avoid similar problems in future.
- The pumps have performed very well, with only minor adjustments to design they can be expected to be very durable.
- Overall successful approach with the combination of well jetting and the use of Canzee Pumps.
- Special attention needs to be paid to solve the detected problems of details.
- Continuous monitoring is still needed for pump and borehole performance including water quality.

5.2 Efficiency of the Programme

- The jetting methodology has proved very efficient at reaching many people in a short period of time. The cost of the pump is not very low (although that would be improved with local production) but the installation cost is very small compared with other methods.
- Thus overall cost-effectiveness has been high.

- The time available in the cyclone response programme did not allow for extensive work with communities to assist them in organizing long-term operation and maintenance, or on promoting environmental sanitation and hygiene.
- Therefore some problems remain in this area. However the different approach taken in Fort Dauphin (Manantenina) does not appear to have given better results. It may be that the high profile involvement of local authorities in Maroantsetra and the relatively low profile of the implementing agency (MEDAIR), which stayed a very short time in the field, played a role in reducing dependency.

6. Recommendations

6.1 Rapid Well Jetting

Keep experimenting with jetting, which potentially could help solve water supply problems for very many people in the low-lying areas of the country.

Rapid Well Jetting

- In order to reach greater depth more effectively the evaluation team recommends that MEDAIR team return to the use of jetting shoes, but they need to develop an efficient method of plugging the jetting shoes once installation is complete, to prevent the problem of sand intrusion.
- We recommend adding a short extension pipe (20 to 30 cm) to the end of the casing shoe, giving the valve in the jetting shoe additional time to close properly when the jetting process stops (quick backflow of sandy water).
- Should for any reason the valve in the jetting shoe not close properly, the end of the casing pipe can be blocked against sand intrusion by a simple but most effective cement plug. The plug, made by filling a specially-made bag with a mixture of cement, sand and gravel, was demonstrated in one of the new boreholes in Maroantsetra and this may provide a solution. (Sealing Casing Pipes by Cement Plug is explained in Annex 7.6).
- Jetting through the casing pipes with a jetting shoe prevents casings from bending during the sinking process, which will eliminate the problem of pumprod pipes and rising main pipes scratching against each other during pump operation.
- Additional fastening of the geo-textile filter (with additional ties) might be advisable, to prevent any displacement of the filter during the jetting process.
- Experiments with more powerful pumps or with two pumps, to provide a greater flow of water to the jetting pipe should also be tried.

Screen with jetting shoe

However, this has the disadvantages of requiring additional equipment and a larger supply of water of jetting water. It may be feasible to drill a temporary shallow well to supply water to the pumps while drilling a permanent installation.

- Another option would be to reduce the diameter of the jetting pipe and casing pipe, although in this case a different handpump type might have to be used because the Canzee design requires a 63 mm diameter casing.
- In urban areas deeper water sources or water treatment will be required, because of the likelihood of bacteriological contamination of shallow groundwater.

Hand Jetting

- Hand-jetting (also known as "sludging") should be investigated, as well as other methods for improving the technique to allow its use to reach greater depths where necessary.
- For hand-jetting, although the evaluators were able to introduce the ideas and demonstrate the technique to the local MEDAIR team, it would be highly advantageous to bring a skilled driller from the Indian sub-continent for a period of perhaps 3 months to work with local teams and train them in the use of this method.
- This driller could also help them to identify situations in which hand-jetting might be more or less appropriate than the current pumped jetting method.
- Hand jetting may be feasible for the installation of Canzee pumps with a 50 mm rising main, provided that the upper section of the borehole (to the typical piston installation depth of 1.5 to 2 meters below the water table) can be drilled wide enough. A smaller diameter screen and casing could then be installed below that depth (see also Annex 7.9).

6.2 The Canzee Pump

Recommended actions to be taken to solve the problems detected:
The majority of problems detected during the evaluation mission are minor faults, which can easily be improved.

a) Handle Problems:

Most of the failures detected were loose or badly worn pump handles. The wear on both sides of the handle hole starts as soon as the handle nuts are being tightened. The relatively sharp corners of the hexagonal nuts are wearing the hole in the wood and once the wear has started, the nuts need regular tightening.

Although this problem causes most pump failures, the rectification is very simple by adding 2 washers (between hardwood and hexagonal nuts).

b) Abrasion of pumprod pipes and plunger due to bent pipes:

If the casing pipe is bent during the jetting process (jetting without jetting shoe), the rising main pipe is forced to follow the bent casing during pump installation and the same applies also to the pumprod pipe. During operation of the handpump, the pumprod pipe is constantly rubbing against the rising main pipe. This causes abrasion on the outside diameter of the pumprod pipes and plunger, but also on the inside diameter of the rising main pipe (not easy visible).

This problem can be drastically reduced when jetting is done through the casing pipes with jetting shoe. With this technique, the straight aluminium pipe of the jetting equipment is inserted into the casing pipes during the jetting process and gives the casing pipe no room for bending.

The problem of bent pipes mentioned above does not exist when installing the Canzee Pump on a dug-well, because there is no casing pipe and the rising main is hanging freely from the pump body into the water of the well.

c) Abrasion of pumprod pipes and plunger due to sand intrusion:

Sand intrusion into the casing pipe can be caused by displacement of the sand filter (geo-textile) during jetting or when the valve of the jetting shoe does not remain properly closed. Sand intrusion into handpumps can cause severe abrasion of all moving parts, no difference whether they are from soft plastic or hard metal material. (Recommended suggestions for eliminating sand intrusion please see 6.1 Rapid Well Jetting.)

d) Broken pumprod due to one-handed pumping:

A few cases have been found with broken pumprods. The rods broke at their weakest point (start of the thread). The reason for this failure is not fully clear, but it could be due to a bending stress on the pumprod when the handle is operated with one hand only.

To avoid this problem, the handle length could be kept to a minimum (30 cm) and instruction should be given to the users to use both hands for operating the pump.

e) Slipped pumprod and riser pipes due to poorly solvent cemented joints:

Defective connections leading to slippage of pumprod and riser pipe joints were only found in a few cases. This problem can easily be avoided by ensuring that the installation personnel follow the necessary instructions. Jointing failures of PVC-U pipes can happen when working conditions during the jointing process are not clean (e.g. failure to remove grease and oil from the connection areas prior to the application of solvent cement).

Other common mistakes are sharp pipe ends (without chamfer), which will “shave” off the applied solvent cement during the jointing movement (see jointing instructions for PVC-U pipes in Annex 7.7).

f) “Knocking” of pump rod:

Three handpumps were found which made a knocking sound at the beginning of the handle up-stroke.

Although the pumps were opened, we could not find the reason for this sound. There must be a protruding part in the pumphead, so that the edge of the first pumprod pipe gets hooked.

Pumprod pipe edge with wearing marks

In one of these pumps we trimmed the edge of the pumprod pipe with a sharp knife (to produce a large chamfer) and the knocking sound almost disappeared.

The third pump we found with this problem showed after dismantling that the pipe edge was wearing considerably. This problem needs special attention by the manufacturer.

g) Bent handle rod due to vandalism:

Bending of the stainless steel handle rod can only happen by accident or by vandalism. Such occasions cannot easily be avoided by technical changes and therefore no suggestions can be made other than guarding the pump with a strong fence or securing the pump handle at its lowest position with a chain and a padlock. However, the number of pumps affected is small and it may not be a significant problem.

6.3 Social and Institutional Sustainability – Internal Factors

This section discusses community-level influences on social and institutional sustainability. External support requirements are discussed in section 6.4.

Social Promotion

For the promotion of hygiene, we recommend the use of PHAST techniques. These are described (see PHAST Initiative: http://www.sanicon.net/titles/title.php3?titleno=24) and are already promoted in Madagascar by WaterAid, UNICEF and others.

In terms of organisation for sustainability, the need for planning ahead, in partnership with local government, is emphasized above. The family approach may be useful where family groups are of sufficient size and the intervention sufficiently cheap to justify it. For sustainability the family group is a good one to use because roles and responsibilities are generally quite clear. Maintenance needs may also be less if fewer people are using the installation.

Environmental Quality and the Hygiene Conditions of Water Points

The programme should produce clear criteria for well siting, with prescribed minimum distances from different pollution sources such as latrines, rice paddies, corrals, etc. The need for higher standard of well apron and drainage have already been discussed. Any interventions required by the community, including fencing and cleaning, should be policed through community byelaws and involvement of the *fokontany*, such as is already happening in Antoraka.

Improvement of the following hygiene conditions at the water points is important:

- Addition of a pump platform with drainage channel,
- Filling all dens and holes near the pump, to avoid standing water,
- No provision of washing facilities near the pump (at least 10 m away),
- No latrine allowed closer than 20 to 30 m from the water point,
- Appropriate fence to keep all animals away from the water point,
- If water needs to be provided for animals, a trough at the end of the drainage channel can be built (at least 10 m away from the pump),
- Regular cleaning of platform and drainage channel is required.

Training of Pump Users

We recommend additional training of pump users in pump handling, maintenance and hygiene. If funding can be found, some extra (refresher) training would be useful for the pumps already installed, particularly for the hygiene points listed above.

Training to community members should provide for all of the maintenance work that is expected to be undertaken within the community, and should also include explanation of how additional external help can be found if needed.

Financial Evaluation

We recommend that good preparation be made for financial sustainability at the commencement of any new installation programme. A framework for discussion should be developed by MEDAIR *before* any installation commences, and this should be used to engage users in decision-making at an appropriate time (which may also be before installation). It is important to identify the most expensive intervention that the community is expected to make. This will depend on the particular installation method and technology used as well as any back-up service that might be expected from government or elsewhere*****.

The community institutions that are built to sustain the installation should logically be able to meet the cost of this intervention, and discussions with the users need to identify realistic means to do this.

Holding large cash reserves is difficult, particularly for rural communities with no access to banking or savings institutions. It has been shown to work in some circumstances (e.g. in Dodoma, Tanzania, where many pump committees hold funds in bank accounts, or in Ethiopia, where large-scale gravity-fed systems hold similar accounts******.

However, this is more usual in larger projects, where many people depend on a single source of water and where a more centralised organisation has been built up. Smaller funds may function where they have a double use, for water supply maintenance and for small-scale credit, but this normally requires additional promotion and capacity building to set up a credit scheme, and relies on the capacity of community members to operate the scheme. It might be feasible in larger rural communities such as Mahalevona.

Frequently communities depend on *ad hoc* contributions when these are required, but these are not reliable, particularly in the period before harvest when people do not have cash available, and for larger sums of money. A better option may be to save money regularly until a stock of parts can be bought, and to buy the parts and keep them until the time of need.

Iron and Smell

The principle to follow is always to try to provide water that does not need treatment. Where shallow water is not fecally polluted and has a lower iron content this should be used in preference to deeper water with high iron content. Treatment for iron (which also causes most of the problems of smell and taste recorded in the Maroantsetra area) is technically simple, using aeration and filtration. However, experience shows that it is rarely maintained effectively, and it introduces the potential for bacteriological contamination of water. Household filtration or filtration at the pump are both possible, and designs exist for both (see treatment possibility on page 19).

* The most expensive intervention may be the replacement of the entire installation, or it may be that the community is only expected to replace pump components or to build a replacement platform.

** Two Case Studies exist from WaterAid Ethiopia; a) “Financial Sustainability” and b) “Water Works”.

Networking

Networking of committees or pump maintenance personnel should also be encouraged so that they can use each other as resources in case of need. Back-up arrangements nevertheless need to be established for more difficult maintenance issues; the different possibilities are discussed in section 6.4.

6.4 Sustainable External Support

The strategy for external support (as well as internal financial sustainability) needs to be built from the planning stage of the programme. Once you accept that there will always be a need for some external support, the consideration of community capacity will dictate the scope of that support. Support can be provided in at least three ways: from the private sector, the public sector or an association.

Private Sector

The private sector has the potential to provide maintenance services, and (according to the arrangements made) to spread the cost of services over time. However, the economics of private sector maintenance must be carefully examined before taking up this option, because a certain critical mass of work is required before a profit can be made. Therefore there must be a certain frequency of paid interventions expected before the private sector can be interested. If such a frequency is expected (because installations will need relatively frequent inspection or because there is a large number of installations) the programme can take steps to identify likely companies or individuals and to provide capacity to them during the installation programme.

Public Sector

Support from the public sector is often relied on, and works in some cases, where the local authority or responsible body is provided with the means (skills and resources) to carry out its responsibilities. Too often, however, it is left with the responsibility but not the means. In Madagascar local government is the *maître d'oeuvre* and therefore has to be involved in some capacity. However it is likely to delegate its responsibility to manage rural water supplies to local communities. It may be able to provide support in terms of its authority to negotiate with private sector and with public funding sources in the event of any major maintenance. It should also be relied on to monitor the overall performance of maintenance arrangements for the facilities, and to take action if performance is not satisfactory. Therefore it needs to have full knowledge of the public installations provided and of their status.

Associations

Associations (which essentially extend the capacity of the users) can be effective instead of the private sector, where profits are expected to be low and where there is a culture of association. In this case the user groups from different installations form an association, which may have some paid employees if it is large, and which holds a central maintenance fund. The association is then responsible for any maintenance work that the users themselves cannot resolve. The association therefore also needs to build links with others including spare parts suppliers and local government.

In the case of Maroantsetra, we recommend that these different options be studied and the most realistic one chosen, according to the parameters of expected cost, capacity in the private and public sectors, culture of association, etc. Without having carried out such a study in Maroantsetra it is difficult to make a recommendation here, but because of the relatively dense population, associations and private sector involvement should be investigated.

Collaboration with Local Authorities and other Support Groups

The project approach for further development projects should follow the route of relying on local authorities for most of the community organisation. Perhaps other local institutions such as health centres and schools should also be used so as to ensure that the implementing agency keeps a fairly low profile and provides direct support for the minimum time possible.

Longer-term backup will also necessarily include local government (the maître d'ouvrage for all public water supplies), but might also involve the private sector or locally-based institutions such as community associations, mayors' associations or church organisations.

We therefore recommend that discussions should be facilitated with relevant local stakeholders, to explore how back-up arrangements can feasibly be set up and managed in Maroantsetra. Discussions should include the District Administration, mayors, local users' representatives, MEDAIR and any interested local organisations or enterprises.

Capacity Building for Local Manufacturing

We note the current initiative by BushProof for the manufacture of Canzee Pumps in Madagascar, and suggest a wider survey of possibilities for local production and developing capacity for pump and spare part manufacture in the country. This is particularly important for two reasons: firstly to reduce the cost of both pumps and spare parts; secondly to ensure the supply of spares in the country. For the second reason it is important to consider local manufacture together with the development of a supply chain for spares (see below).

Any newly developed or changed pump component needs to be interchangeable with all Canzee Pump models already installed in Madagascar. Otherwise existing pumps will have to be replaced.

Supply Chain

As mentioned above, sustainability in the long term requires finding possibilities for a feasible supply chain of spare parts (see example in Annex 7.8). Without this, even a good handpump will eventually break down and will not be capable of repair. The supply chain, of course, has to run from the producer to the end user, so it must make spare parts available to village-based committees. Programmes and authorities that use the Canzee Pump must therefore work with manufacturers to establish an effective supply chain.

6.5 The Future of the Evaluated Technologies in Madagascar

Besides further experimenting to improve the promising jetting results achieved so far, special concentration is also required to eliminate the few existing problems of the Canzee Pump, detected during the evaluation mission (see 6.1 and 6.2). With this provison, we recommend that installation of Canzee Pumps on jetted wells should be continued to build on the clear successes of the programme to date.

However a massive expansion of the programme should not be envisaged before further time has elapsed, allowing for longer-term evaluation of bacteriological quality of water and of maintenance problems with the handpumps. We therefore suggest that a similar number of pumps (between 100 and 300) should be installed over the next two years, at which time there should be a further evaluation of results.

Monitoring

Particularly because both the pump and the installation techniques are new to Madagascar and relatively untested elsewhere, it is most important to ensure continuous monitoring of technical failures and problems detected.

We recommend that this activity be carried out jointly between Medair, the Malagasy government and other interested parties, so that the usefulness of the methods and equipment can be properly verified and made known. Continued monitoring will permit constant improvement of the well jetting and the Canzee Pumps.

Regular monitoring of bacteriological Water Quality, especially of water points with questionable conditions and in “semi-urban” areas like Mahalevona, should also be continued to ensure that the shallow installations are still providing potable water.

**Evaluation of Rapid Well Jetting
and the
Canzee Handpump**

Annex 7.1

Summary of Data Collected

Divided in:

- General Information (Summary sheet 1)
- Environment and Water Quality (Summary sheet 2)
- Well and Handpump performance (Summary sheet 3)
- User committee and Water use (Summary sheet 4)
- General Information Manantenina (Manantenina Summary)

Medair evaluation mission — Summary sheet 1

Evaluat. date	Eval	Village	District	Pump No.	Install. date	Water point	Well depth (m)	SWL (m)	Cylinder depth (m)	Pump works well?	Discharge (lt/min)	No. of users	Comments
14/09/05	KE	Rantabe	Maroantsetra	R 13	07/10/04	Bh	6.0	3.8	5.2	yes	18	65	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 02/14	05/10/04	Bh	4.4	1.8	3.6	yes	22	210	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 05/06	05/10/04	Bh	6.0	3.2	5.2	yes	21	150	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 07	05/10/04	Bh	?	3.0	?	yes	20	110	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 13	06/10/04	Bh	5.3	3.7	4.5	yes	23	135	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 02/03	05/10/04	Bh	?	?	?	yes	33	150	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 01	05/10/04	Bh	4.4	1.6	3.6	yes	24	100	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 15/16	04/10/04	Bh	6.0	2.7	5.2	yes	24	190	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 10/09	06/10/04	Bh	5.6	2.6	4.8	yes	22	80	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 08	06/10/04	Bh	4.9	2.2	4.1	yes	24	175	
14/09/05	KE	Ambanizana	Maroantsetra	AZ 11	06/10/04	Bh	5.2	3.5	4.4	yes	34	86	
15/09/05	KE	Rantabe	Maroantsetra	R 01	06/10/04	Bh	6.1	4.0	5.3	yes	24	40	
15/09/05	KE	Rantabe	Maroantsetra	R 02	05/10/04	Bh	5.3	3.5	4.5	yes	20	40	
15/09/05	KE	Rantabe	Maroantsetra	R 03	06/10/04	Bh	5.0	3.7	4.2	yes	26	65	
15/09/05	KE	Rantabe	Maroantsetra	R 04	05/10/04	Bh	6.1	3.5	5.3	yes	20	40	
15/09/05	KE	Rantabe	Maroantsetra	R 07	06/10/04	Bh	5.7	3.7	4.9	yes	25	60	
15/09/05	KE	Rantabe	Maroantsetra	R 08	06/10/04	Bh	5.9	2.8	5.1	yes	24	70	
15/09/05	KE	Mahalevona	Maroantsetra	MV 18	14/10/04	Bh	6.2	3.2	5.4	acceptable	16	200	In dry season reduced flow of water.
15/09/05	KE	Mahalevona	Maroantsetra	MV 22	13/10/04	Bh	6.4	4.1	5.6	yes	24	130	
15/09/05	KE	Mahalevona	Maroantsetra	MV 09	13/10/04	Bh	6.8	3.6	6.0	acceptable	13	330	Water used for drinking and cooking only.
15/09/05	KE	Mahalevona	Maroantsetra	MV 26	13/10/04	Bh	5.9	3.9	5.1	yes	20	350	
15/09/05	KE	Mahalevona	Maroantsetra	MV 32/34	14/10/04	Bh	4.5	3.5	3.7	yes	25	240	
15/09/05	KE	Mahalevona	Maroantsetra	MV 27	14/10/04	Bh	5.0	2.7	4.2	yes	23	325	
15/09/05	KE	Mahalevona	Maroantsetra	MV 12	13/10/04	Bh	4.7	2.7	3.9	yes	30	195	
15/09/05	KE	Mahalevona	Maroantsetra	MV 02	13/10/04	Bh	5.2	2.2	4.4	yes	24	100	
15/09/05	KE	Mahalevona	Maroantsetra	MV 28	14/10/04	Bh	5.4	3.4	4.6	yes	30	165	
15/09/05	KE	Mahalevona	Maroantsetra	MV 29	13/10/04	Bh	5.1	2.6	4.3	yes	21	65	
17/09/05	KE	Andranofotsy	Maroantsetra	AB 02	07/09/04	Bh	4.8	1.5	4.0	yes	20	125	
17/09/05	KE	Andranofotsy	Maroantsetra	AB 31	23/09/04	Bh	?	1.3	?	yes	28	70 / 120	More users; people without pump accepted.
17/09/05	KE	Andranofotsy	Maroantsetra	AB 04	08/09/04	Bh	4.8	1.0	4.0	yes	22	45	
17/09/05	KE	Andranofotsy	Maroantsetra	AB 07/06	08/09/04	Bh	4.8	1.6	4.0	yes	25	140	

Evaluat. date	Eval	Village	District	Pump No.	Install. date	Water point	Well depth (m)	SWL (m)	Cylinder depth (m)	Pump works well?	Discharge (lt/min)	No. of users	Comments
17/09/05	KE	Andranofotsy	Maroantsetra	AB a	27/07/04	Bh	?	?	?	yes	27	230	Funds have been collected; to pay repairs.
17/09/05	KE	Andranofotsy	Maroantsetra	AB 29	09/09/04	Bh	4.7	1.2	3.9	yes	24	130	
18/09/05	KE	Antoraka	Maroantsetra	AT 01	25/11/04	Bh	3.9	2.5	3.1	yes	21	100	
18/09/05	KE	Antoraka	Maroantsetra	AT 02	25/11/04	Bh	?	?	?	yes	18	110	
18/09/05	KE	Antoraka	Maroantsetra	AT 03	25/11/04	Bh	?	?	?	yes	24	145	
18/09/05	KE	Antoraka	Maroantsetra	AT 04	25/11/04	Bh	?	?	?	yes	25	135	
18/09/05	KE	Antoraka	Maroantsetra	AT 05	25/11/04	Bh	?	?	?	yes	27	90	
18/09/05	KE	Antoraka	Maroantsetra	AT 15	25/11/04	Bh	?	?	?	yes	28	95	
18/09/05	KE	Antoraka	Maroantsetra	AT 10	24/11/04	Bh	?	?	?	yes	30	100	
15/09/05	JWG	Rantabe	Maroantsetra	R 11	06/10/04	Bh	5.9	3.2	5.1	yes	24	55	
14/09/05	JWG	Nandrahanana	Maroantsetra	N 03	05/10/04	Bh	3.9	0.7	3.1	no	2	130	
14/09/05	JWG	Nandrahanana	Maroantsetra	N 01	05/10/04	Bh	4.0	1.4	3.2	yes	30	65	
14/09/05	JWG	Nandrahanana	Maroantsetra	N 02	05/10/04	Bh	3.3	1.5	2.5	yes	20	80	
14/09/05	JWG	Rantabe	Maroantsetra	R a	12/07/04	Bh	4.6	3.6	3.8	yes	15	>200	More users; poor quality in nearby wells.
14/09/05	JWG	Nandrahanana	Maroantsetra	N 05	05/10/04	Bh	5	3	4.2	no	?	>200	
15/09/05	JWG	Rantabe	Maroantsetra	R 15	07/10/04	Bh	6.5	3.7	5.7	yes	21	20	
15/09/05	JWG	Rantabe	Maroantsetra	R 14	07/10/04	Bh	5.7	3.9	4.9	yes	24	75	
15/09/05	JWG	Rantabe	Maroantsetra	R 12	07/10/04	Bh	5.0	3.9	4.2	yes	25	50	
14/09/05	JWG	Rantabe	Maroantsetra	R 06	06/10/04	Bh	5.1	?	4.3	?	?	?	
15/09/05	JWG	Rantabe	Maroantsetra	R b	?	Bh	4.4	3.6	3.6	yes	18	>65	More users; because Pump R 10 is broken.
15/09/05	JWG	Rantabe	Maroantsetra	R 10	06/10/04	Bh	5.9	4.1	5.1	no	?	80	
15/09/05	JWG	Rantabe	Maroantsetra	R 09	06/10/04	Bh	6.6	3.6	5.8	yes	?	?	
15/09/05	JWG	Mahalevona	Maroantsetra	MV 30	14/10/04	Bh	5.4	2.6	4.6	yes	20	100	Short rope restricts handle movement.
15/09/05	JWG	Mahalevona	Maroantsetra	MV 33	14/10/04	Bh	4.0	1.9	3.2	yes	21	185	
15/09/05	JWG	Mahalevona	Maroantsetra	MV 13	14/10/04	Bh	5.0	2.4	4.2	yes	25	95	Some iron staining on platform.
15/09/05	JWG	Mahalevona	Maroantsetra	MV 04	14/10/04	Bh	6.6	3.5	5.8	yes	23	195	Some iron staining on platform.
15/09/05	JWG	Mahalevona	Maroantsetra	MV 01	13/10/04	Bh	6.0	3.0	5.2	no	?	?	
15/09/05	JWG	Mahalevona	Maroantsetra	MV 05	13/10/04	Bh	4.8	2.42	4.0	yes	21	35	Heavy iron staining.
15/09/05	JWG	Mahalevona	Maroantsetra	MV 14	13/10/04	Bh	4.7	2.7	3.9	yes	17	65	Some iron staining on platform.
15/09/05	JWG	Mahalevona	Maroantsetra	MV 03	13/10/04	Bh	5.7	2.8	4.9	yes	19	80	
15/09/05	JWG	Mahalevona	Maroantsetra	MV 25	14/10/04	Bh	6.2	3.2	5.4	no	?	455	

Evaluat. date	Eval	Village	District	Pump No.	Install. date	Water point	Well depth (m)	SWL (m)	Cylinder depth (m)	Pump works well?	Discharge (lt/min)	No. of users	Comments
17/09/05	JWG	Andranofotsy	Maroantsetra	AF a	27/07/04	Bh	3.7	1.2	2.9	yes	19	CSB	Just used by health centre.
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 14	21/10/04	Bh	5.2	2.9	4.4	yes	19	80	Some iron staining on platform.
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 19	21/09/04	Bh	3.6	2.5	2.8	yes	20	110	Reinstalled; original depth 5.2 m.
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 20	22/09/04	Bh	?	1.6	?	yes	20	100	
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 12	21/09/04	Bh	5.2	1.9	4.4	yes	26	60	
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 15	20/09/04	Bh	5.0	1.5	4.2	no	10	65	Discharge for 60 short strokes.
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 13	20/09/04	Bh	4.9	1.6	4.1	yes	21	>200	Public pump at market; some iron staining.
17/09/05	JWG	Andranofotsy	Maroantsetra	AF 08	20/09/04	Bh	3.1	1.3	2.3	yes	21	85	Reinstalled; original depth 5.0 m.

Medair evaluation mission — Summary sheet 2

Pump no	Site neat	Pollution source	Turbid or sandy	Bad taste	Bad smell	Other sources nearby	Fenced	Comments
R 13	yes	none	no	no	no	River	no	none
AZ 02/14	yes	Washing slab	no	no	no	River	no	Washing slab to be placed at least 10 to 15 m away from the water source.
AZ 05/06	no	Latrine 10 m	no	no	no	River	no	Toilet to be placed at least 30 to 40 m away from the water source.
AZ 07	no	none	no	no	no	River	no	none
AZ 13	yes	none	no	no	yes	River	no	Water is clear but smells muddy; when pump is operated for a long time.
AZ 02/03	no	Next to road	no	salty	no	River	no	Users not disturbed by the minimal salty taste.
AZ 01	yes	none	no	no	no	River	no	none
AZ 15/16	no	Poor drain	no	no	no	Dug-well	no	Ponds near the pump to be filled to avoid standing water.
AZ 10/09	no	none	no	no	no	River	no	none
AZ 08	no	none	no	no	no	River	no	none
AZ 11	yes	none	no	no	no	River	no	Pump elevated with drain towards the nearby road.
R 01	no	none	no	yes	yes	Mangrove	yes	Sulfur smell and oxidation of downhole components.
R 02	no	none	sandy	yes	yes	Mangrove	yes	Sulfur smell, no oxidation.
R 03	no	none	no	no	no	River	yes	none
R 04	no	none	no	yes	yes	River	no	Sulfur smell and oxidation of downhole components.
R 07	no	Paddy 20 m	no	yes	yes	River	no	Sulfur smell and oxidation of downhole components.
R 08	no	none	no	yes	yes	River	no	Sulfur smell and oxidation of downhole components.
MV 18	no	Dense popul.	no	no	no	Dug-well	yes	Too close to houses, Pump sheltered.
MV 22	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses, Pump sheltered.
MV 09	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses, Pump sheltered.
MV 26	no	Dense popul.	no	no	no	Dug-well	yes	Too close to houses, Pump sheltered.
MV 32/34	no	Dense popul.	no	no	no	Dug-well	yes	Too close to houses, Pump sheltered.
MV 27	no	Dense popul.	no	little	little	Dug-well	yes	Too close to houses, Pump sheltered.
MV 12	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses, User's concerned about red layer.
MV 02	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses, Pump sheltered.
MV 28	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses, Pump sheltered.
MV 29	no	Dense popul.	slightly red	yes	yes	Dug-well	yes	Too close to houses. User's asked why water gets dark when cooking vegetables.
AB 02	no	none	no	no	no	River	no	none
AB 31	no	none	slightly red	yes	yes	River	no	Little sulfur smell and oxidation of downhole components.
AB 04	no	none	no	no	no	River	no	none
AB 07/06	no	House 5 m	no	no	no	River	no	Ponds near the pump to be filled to avoid standing water.
AB a	no	House 5 m	no	no	no	River	no	Too close to houses.
AB 29	no	House 5 m	no	no	no	River	no	Too close to houses.
AT 01	yes	none	no	no	yes	Dug-well	yes	none

Pump no	Site neat	Pollution source	Turbid or sandy	Bad taste	Bad smell	Other sources nearby	Fenced	Comments
AT 02	yes	House 10 m	no	no	little	Dug-well	yes	Too close to houses.
AT 03	yes	none	no	no	no	damaged well	yes	Damaged well to be filled with sand for safety (no protection from falling into it).
AT 04	yes	House 5 m	no	no	no	Dug-well	no	Too close to houses.
AT 05	yes	Washing slab	little turbid	little	little	none	yes	Washing slab to placed at least 10 to 15 m away from the water source.
AT 15	yes	Washing slab	no	salty	no	Beach 100m	yes	Washing slab to placed at least 10 to 15 m away from the water source.
AT 10	yes	Washing slab	no	no	little	Mangrove	yes	Washing slab to placed at least 10 to 15 m away from the water source.
R 11	yes	Latrine 20 m	sandy	no	no	none	no	none
N 03	no	Paddy 4 m	sandy	no	no	Other pumps	no	none
N 01	no	none	no	no	no	none	yes	none
N 02	no	none	no	no	yes	River	no	none
R a	no	none	no	no	no	River	no	none
N 05	no	none	sandy	no	no	Dug-well	no	none
R 15	yes	none	no	no	no	Dug-well	yes	Flowers planted near well, traditional dug-well with wooden lining.
R 14	no	none	sandy	no	no	Dug-well	no	Fine sand since installation
R 12	no	none	no	no	no	Dug-well	no	none
R 06	no	Paddy 25 m	no	yes	yes	Other pumps	no	none
R b	yes	none	no	no	no	Springs	yes	Children maintain pump surrounding with grass and flowers.
R 10	yes	none	no	no	no	Dug-well	yes	Plants around pump.
R 09	no	none	no	no	no	Dug-well	no	Raised 60 cm above surrounding ground level because reinstallation was high.
MV 30	yes	Dense popul.	no	no	no	Dug-well	no	Pump sheltered.
MV 33	no	Latrine 10 m	sandy	no	no	Dug-well	yes	Pump sheltered; pumps sand at dry times of year.
MV 13	no	Latrine 25 m	turbid	no	no	Dug-well	no	Pump sheltered but poorly maintained.
MV 04	no	Poor drain	no	no	no	Dug-well	no	Standing water to be eliminated.
MV 01	no	none	sandy	no	no	Dug-well	no	Pump sheltered.
MV 05	yes	none	no	yes	yes	Dug-well	no	Pump shelter; sand and wood surround.
MV 14	yes	none	no	no	no	Dug-well	no	Pump shelter; some fine sand for 1 week after installation.
MV 03	yes	none	no	no	no	Dug-well	yes	Pump shelter; sign says "don't wash here"; flowers and grass planted.
MV 25	no	none	no	no	no	Dug-well	no	Pump sheltered.
AF a	no	Latrine 30 m	no	no	no	none	yes	Within Health Centre compound.
AF 14	no	Poor drain	no	no	no	River	no	Ponds near the pump to be filled to avoid standing water.
AF 19	no	none	no	no	no	Dug-well	no	Initial installation had very high iron content.
AF 20	no	River 15 m	no	no	no	River	no	Pump has a drain!
AF 12	no	River 40 m	sandy	no	no	River	no	Some micaceous fine sand.
AF 15	no	none	sandy	no	no	Dug-well	no	Some fine sand.
AF 13	no	Market 1 m	no	no	no	Dug-well	no	none

Pump no	Site neat	Pollution source	Turbid or sandy	Bad taste	Bad smell	Other sources nearby	Fenced	Comments
AF 08	no	Poor drain	no	no	no	Dug-well	no	Ponds near the pump to be filled to avoid standing water (near rod).

Medair evaluation mission — Summary sheet 3

		Breakdown because of:						Maintenance work done:						
Pump No.	Jetting shoe used	Pump difficult	Sand intrusion	Handle	Pump rod	Valves	Other	Handle nuts	New handle	Valve flap	Cleaned of sand	Pipes	Other	Comments
R 13	unknown	no	no	no	no	no	none	no	no	no	no	no	none	No intervention so far.
AZ 02/14	unknown	no	yes	no	no	no	none	no	no	no	yes	no	none	none
AZ 05/06	unknown	no	yes	no	no	no	none	yes	no	no	yes	no	none	Caretaker not in the village, therefore handle not repaired.
AZ 07	unknown	no	no	no	no	no	none	no	no	no	no	no	none	No intervention so far.
AZ 13	unknown	no	no	no	no	no	none	no	no	no	no	no	none	No intervention so far.
AZ 02/03	unknown	no	yes	no	no	no	none	no	yes	no	yes	no	Handle tied	none
AZ 01	unknown	no	no	no	no	no	none	yes	no	no	no	no	none	none
AZ 15/16	unknown	no	no	yes	no	no	none	no	no	no	no	no	none	No intervention so far.
AZ 10/09	unknown	no	no	no	yes	no	none	no	yes	no	no	no	Handle tied	A committee member of another pump made the repair.
AZ 08	unknown	no	no	no	no	yes	none	no	no	yes	no	no	none	Flap changed.
AZ 11	unknown	no	no	no	no	no	none	no	no	no	no	no	none	No intervention so far.
R 01	unknown	no	no	no	no	no	none	yes	no	no	no	no	Pumprod	Length of pumprod too long; a number of rubber discs has been added, so that piston is not knocking the footvalve.
R 02	unknown	no	yes	no	no	no	none	no	no	no	yes	no	Rising main	Regular sand intrusion; placing of mosquito net at the end of rising main to prevent that sand is pumped.
R 03	unknown	no	no	no	no	no	none	no	no	no	no	no	Handle rod	none
R 04	unknown	no	no	yes	no	no	none	yes	no	no	no	no	none	Instruction given that nuts need to be teight to prevent that they are spoiling the handle.
R 07	unknown	no	no	no	no	no	none	no	yes	no	no	no	Handle tied	none
R 08	unknown	no	no	no	no	no	none	yes	no	no	no	no	none	Instruction given that nuts need to be teight to prevent that they are spoiling the handle.
MV 18	unknown	no	yes	no	no	no	none	no	yes	no	yes	no	Handle tied	No interventiom so far.
MV 22	unknown	no	no	no	yes	no	none	no	no	no	no	yes	none	Pumprod jammed in rising main (red layer).

		Breakdown because of:						Maintenance work done:						
Pump No.	Jetting shoe used	Pump difficult	Sand intrusion	Handle	Pump rod	Valves	Other	Handle nuts	New handle	Valve flap	Cleaned of sand	Pipes	Other	Comments
MV 09	unknown	yes	no	no	yes	no	none	no	no	no	no	yes	none	Pumprod damaged, broken at the thread, turned up-side-down (needs repair).
MV 26	unknown	yes	no	no	no	no	none	no	no	no	no	yes	none	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Pipes and pumprod have a red layer.
MV 32/34	unknown	no	yes	no	no	no	yes	yes	no	no	no	yes	Footvalve	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Footvalve leaking (possible sand intrusion). Pipes and pumprod have a red layer .
MV 12	unknown	no	yes	no	no	no	none	no	no	no	yes	yes	1 bolt missing	Not clear how sand was removed, caretaker was not available.
MV 02	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	No intervention so far.
MV 28	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	No intervention so far.
MV 29	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	1x cleaned by LANGAP. An English student arrived in July 2004 and dismanteled the pump no-one knows this person (similar reports were received by other users).
AB 02	unknown	no	yes	no	yes	no	none	no	no	no	yes	no	none	Rectified by MEDAIR
AB 31	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Pipes and pumprod have a little red layer.
AB 04	unknown	no	no	no	yes	no	none	no	yes	no	no	yes	none	Rectified by MEDAIR. Pumprod touching rising main, riser pipes bent or pumprod connection not straight.
AB 07/06	unknown	no	no	no	no	no	none	no	yes	no	no	yes	Handle tied	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Footvalve slightly leaking (possible sand intrusion).

		Breakdown because of:						Maintenance work done:						
Pump No.	Jetting shoe used	Pump difficult	Sand intrusion	Handle	Pump rod	Valves	Other	Handle nuts	New handle	Valve flap	Cleaned of sand	Pipes	Other	Comments
AB a	unknown	no	no	no	yes	no	none	no	yes	no	no	no	Handle tied	Rectified by MEDAIR, second repair because a dunken man bent the pumprod.
AB 29	unknown	no	no	no	yes	no	none	no	yes	no	no	no	none	Rectified by MEDAIR, second repair required because someone bent the pumprod (maybe the same person as pump with no number).
AT 01	unknown	no	no	no	no	no	none	no	no	no	no	no	none	1 x dismantled by Keith Porter (English student).
AT 02	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	Pumprod touching rising main, riser pipes bent or pumprod connection not straight.
AT 03	unknown	no	no	no	no	no	none	no	no	no	no	no	none	1 x dismantled by Keith Porter (English student).
AT 04	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Pipes and pumprod have a little red layer.
AT 05	unknown	yes	no	no	no	no	none	no	no	no	no	yes	none	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. One pumprod connection needs to be glued - water is leaking.
AT 15	unknown	no	no	no	no	no	none	no	no	no	no	yes	Pumprod pipe	Pumprod touching rising main, riser pipes bent or pumprod connection not straight. Upper end of pumprod pipe knocking against the inner flange of the pump housing. Shamfer for guiding made at the pipe end.
AT 10	unknown	no	no	no	no	no	none	no	no	no	no	yes	none	none
R 11	yes	no	no	no	no	no	none	yes	no	no	no	no	none	
N 03	yes	no	yes	no	no	no	none	no	no	no	no	no	none	
N 01	yes	no	no	no	yes	no	none	no	no	no	no	no	Handle rod	
N 02	yes	yes	no	no	no	no	none	no	no	no	no	no	none	Pump rod rubs on casing.

		Breakdown because of:						Maintenance work done:						
Pump No.	Jetting shoe used	Pump difficult	Sand intrusion	Handle	Pump rod	Valves	Other	Handle nuts	New handle	Valve flap	Cleaned of sand	Pipes	Other	Comments
R a	no	no	no	no	no	no	none	no	no	no	no	no	none	Cash collected once.
N 05	yes	no	yes	no	no	no	none	no	no	no	yes	no	none	Jammed with sand for second time, 3 months ago.
R 15	yes	no	no	no	yes	no	none	loose	no	no	no	yes	none	Pump rod joint repaired with glue left over from project.
R 14	yes	no	yes	no	yes	no	none	yes	no	no	yes	yes	none	Handle rod bottom nut loose. Rod jammed with sand, then came apart and re-glued.
R 12	yes	no	no	no	yes	no	none	no	no	no	no	no	Handle rod	Rod broke at thread. Handle held on with strapping.
R 06	yes	no	no	no	no	no	none	no	no	no	no	no	none	
R b	no	no	no	yes	no	no	none	no	no	no	no	no	none	No maintenance done since installation.
R 10	yes	yes	yes	no	no	no	none	no	no	no	yes	no	none	Hole re-jetted Oct 04 and replaced with pump rod 10 cm too long; also not straight into hole so stiff action. No handle (worn right through). Theo needed pliers to remove lock nut at top of handle rod (villagers could not do this).
R 09	yes	yes	yes	no	no	no	none	no	no	no	yes	no	none	Hole re-jetted Oct 04 and replaced with pump rod 60cm too long; also not straight into hole so slightly stiff action.
MV 30	yes	no	yes	no	no	no	none	no	yes	no	yes	no	none	Cleaned sand once in Dec 04; string on handle since then and no more sand.
MV 33	yes	no	no	no	no	yes	none	yes	no	no	no	no	none	Handle hole eroded; no sand since English student came in June.
MV 13	yes	no	no	no	no	no	none	yes	yes	no	no	no	none	Handle rod guide not tight.
MV 04	yes	no	no	no	no	no	none	no	no	no	no	no	Handle rod	Handle rod jammed at top of upstroke; freed by caretaker; handle rod guide not tight.
MV 01	yes	no	yes	no	no	no	none	no	no	no	yes	no	none	No sand till March; thencleaned 3 times but jammed again; not working since April.

		Breakdown because of:						Maintenance work done:						
Pump No.	Jetting shoe used	Pump difficult	Sand intrusion	Handle	Pump rod	Valves	Other	Handle nuts	New handle	Valve flap	Cleaned of sand	Pipes	Other	Comments
MV 05	yes	no	no	no	no	no	none	yes	no	no	no	no	none	
MV 14	yes	no	no	no	no	no	none	no	no	no	no	no	Pump shelter	
MV 03	yes	yes	no	no	yes	no	none	no	no	no	no	yes	none	Users put money together and bought Araldite Rapid glue to mend pump rod, in July; slightly stiff to pump, since installation.
MV 25	yes	yes	no	no	yes	no	none	no	no	no	no	no	none	Pump rod coupler has broken; rod and rising main removed and top covered with plastic, since August; scratches on rod suggest friction.
AF a	no	no	no	no	no	no	none	no	no	no	no	no	none	
AF 14	yes	no	yes	no	no	no	none	no	no	no	yes	no	none	Had to clean sand out four times per week after installation; reinstalled in February without jetting shoe.
AF 19	yes	no	no	no	no	no	none	no	no	no	no	no	none	Reinstalled for high iron content.
AF 20	yes	no	yes	no	no	no	none	yes	no	no	yes	no	none	Cleaned sand weekly for a month (in the river!); reinstalled in February; valves don't seal.
AF 12	yes	no	no	no	no	no	none	yes	no	no	no	no	none	Medair installed a plug and sand diminished, but then returned.
AF 15	yes	yes	yes	no	no	no	none	no	no	no	yes	no	Handle tied	Handle tied to limit upstroke to 20 cm, to help reduce sand intake; sand cleaned out about 4 times (in river!)
AF 13	yes	no	no	no	yes	no	none	no	no	no	yes	no	Handle rod	Rod broke at thread. Handle held on with metal washer and single nut; pump rod scratched.
AF 08	yes	no	no	no	no	no	none	yes	no	no	no	no	none	Reinstalled for high iron content; handle hole enlarged.

Medair evaluation mission — Summary sheet 4

Pump No.	Committee functional?	Women members	Opinion of quality	Pumped water used for: Drinking	Cooking	Bathing	Clothes	Animals	Comments
R 13	yes	none	good	yes	yes	yes	yes	no	none
AZ 02/14	yes	none	good	yes	yes	yes	yes	no	none
AZ 05/06	yes	none	good	yes	yes	yes	yes	no	none
AZ 07	no	none	very good	yes	yes	yes	yes	no	none
AZ 13	no	none	good	yes	yes	yes	yes	no	none
AZ 02/03	yes	none	acceptable	yes	yes	yes	yes	yes	none
AZ 01	no	1 of 3	good	yes	yes	yes	yes	no	none
AZ 15/16	yes	2 of 4	very good	yes	yes	yes	yes	no	Some of the users prefer to bath and wash in the river.
AZ 10/09	no	none	good	yes	yes	yes	yes	no	none
AZ 08	yes	none	very good	yes	yes	yes	yes	no	none
AZ 11	yes	none	good	yes	yes	yes	yes	no	none
R 01	no	none	poor	yes	yes	yes	yes	no	none
R 02	no	2 of 5	poor	yes	yes	yes	yes	no	none
R 03	no	1 of 2	good	yes	yes	yes	yes	no	none
R 04	no	2 of 4	poor	no	yes	yes	yes	no	Drinking water of Pump R3.
R 07	yes	none	poor	yes	yes	yes	yes	no	none
R 08	no	none	poor	yes	yes	no	no	no	In dry season, water is also used for bathing and washing.
MV 18	yes	none	good	yes	yes	no	no	no	Flow of water reduced in dry season.
MV 22	yes	none	poor	no	no	yes	yes	yes	Drinking water is taken from other pumps.
MV 09	yes	none	poor	yes	yes	no	no	no	none
MV 26	no	none	good	yes	yes	no	no	no	none
MV 32/34	no	1 of 4	very good	yes	yes	no	no	no	none
MV 27	no	none	good	yes	yes	yes	yes	no	none
MV 12	yes	none	poor	yes	yes	yes	no	no	none
MV 02	no	1 of 3	poor	yes	yes	yes	yes	no	Rinsing white cloths in river.
MV 28	no	1 of 3	poor	yes	yes	yes	yes	no	none
MV 29	no	1 of 3	poor	yes	yes	no	no	no	Only some of the users take this water for drinking and cooking.
AB 02	yes	2 of 3	good	yes	yes	no	no	no	Water quality improved after intervention of MEDAIR: down hole components shortened, because pumping of turbid water, contaminated with iron oxyde (red colour).
AB 31	yes	1 of 3	very good	yes	yes	yes	yes	no	none
AB 04	yes	1 of 3	very good	yes	yes	yes	yes	no	Water quality improved after intervention of MEDAIR: down hole components shortened, because pumping of turbid water, contaminated with iron oxyde (red colour).

Pump No.	Committee functional?	Women members	Opinion of quality	Drinking	Cooking	Bathing	Clothes	Animals	Comments
AB 07/06	yes	none	good	yes	yes	no	no	no	none
AB a	yes	1 of 3	good	yes	yes	no	no	no	Water quality improved after intervention of MEDAIR: down hole components shortened, because pumping of turbid water, contaminated with iron oxyde (red colour).
AB 29	no	1 of 3	good	yes	yes	yes	yes	no	Water quality improved after intervention of MEDAIR: down hole components shortened, because pumping of turbid water, contaminated with iron oxyde (red colour).
AT 01	yes	none	good	yes	yes	yes	yes	no	none
AT 02	yes	none	good	yes	yes	yes	yes	no	none
AT 03	yes	none	very good	yes	yes	yes	yes	no	none
AT 04	yes	none	very good	yes	yes	yes	yes	no	none
AT 05	yes	none	good	yes	yes	yes	yes	no	none
AT 15	yes	1 of 3	acceptable	yes	yes	yes	yes	no	Users asked whether salt content is harmful (water testing sample taken).
AT 10	yes	none	good	yes	yes	yes	yes	no	none
R 11	no	none	good	yes	yes	yes	yes	no	none
N 03	no	1 of 2	poor	yes	yes	no	no	no	none
N 01	yes	none	good	yes	yes	yes	no	no	none
N 02									none
R a	yes	2 of 4	good	yes	yes	yes	no	no	none
N 05	no	none	good						none
R 15	yes	none	good	yes	yes	yes	yes	yes	Woman caretaker
R 14	no	none							Asked neighbouring committee for help with repair
R 12	yes	1 of 3	good	yes	yes	yes	yes	yes	none
R 06	no	none	poor	no	no	yes	no	no	Water used for washing pots.
R b	yes	none	good	yes	yes	no	no	no	none
R 10	no	none							none
R 09									none
MV 30	no	1 of 2	good	yes	yes	yes	no	no	Shopkeeper has tools; paid for new handle himself; 14 lpd
MV 33	no	1 of 4	good	yes	yes	yes	yes	no	Caretaker knows how to disassemble
MV 13	no	none	good	yes	yes	no	no	no	Daily consumption 8 lt/capita. Landowner replaced handle; "he should repair the shelter", say users.
MV 04	no	none	good	yes	yes	yes	yes	no	Daily consumption 10 lt/capita.
MV 01									none
MV 05	no	none	poor	no	no	yes	no	yes	Water used for washing pots.
MV 14	no	none	good	yes	yes	no	no	yes	Water used for washing pots. Women replaced pump shelter bamboos
MV 03	yes	none	good	yes	yes	yes	yes	no	

Pump No.	Committee functional?	Women members	Opinion of quality	Drinking	Cooking	Bathing	Clothes	Animals	Comments
MV 25	yes	none	good	yes	yes	yes	yes	no	Caretaker removed pipes, but does not know how to re-glue the pump rod.
AF a	no	none	good	yes	yes	yes	yes	no	Caretaker lives nearby but does not use well.
AF 14	yes	1 of 3	good	yes	yes	no	yes	no	Daily consumption 10 lt/capita. Don't know where to get new flap valve.
AF 19	yes	none	good	yes	yes	yes	yes	no	Daily consumption 7 lt/capita. Most people did not use pump before reinstallation; they are not clear on how to disassemble the pump.
AF 20	yes	none	good	yes	yes	no	yes	no	
AF 12	yes	1 of 3	good	yes	yes	no	no	no	
AF 15	yes	none	poor	yes	yes	yes	yes	no	Daily consumption 6 lt/capita. Committee cleans sand as needed, when pump jams.
AF 13	no	none	good	yes	yes	yes	yes	no	
AF 08	yes	none	good	yes	yes	yes	yes	no	Before reinstallation, only used for washing pots

Medair evaluation mission **Manantenina Summary**

Evaluation date	Eval	Village	District	Pump No.	Installation date	Water source	Dug-well depth (m)	SWL (m)	Pump works well?	No. of users	Site neat	Fenced	Pollution source	Other sources nearby	Comments
09/09/05	KE	Emanevy	Manantenina	OP-60/002	--	D-well	4.1	2.7	yes	185	yes	no	none	none	none
09/09/05	KE	Bekininy	Manantenina	OP-60/005	--	D-well	3.1	0.8	yes	290	yes	yes	none	River	none
09/09/05	KE	Vohitrarivo	Manantenina	OP-60/006	--	D-well	7.1	3.9	yes	220	yes	yes	none	none	none
09/09/05	KE	Manantenina centre	Manantenina	OP-60/007	11/12/03	D-well	7.4	5.8	no	284	yes	no	none	none	none
09/09/05	KE	Mahantsara	Manantenina	OP-60/008	19/11/03	D-well	4.2	2.3	yes	88	yes	yes	none	Open well	Pump not working, riser pipe slipped, pump head flange to be replaced.
09/09/05	KE	Ampasimasay nord	Manantenina	OP-60/009	18/12/03	D-well	6.6	4.5	yes	145	yes	yes	unknown	River	none
09/09/05	KE	Ampasimasay cent	Manantenina	OP-60/010	01/12/03	D-well	7.0	4.5	yes	50	yes	no	none	none	none
09/09/05	KE	Ampasimasay sud	Manantenina	OP-60/011	--	D-well	6.6	4.6	yes	140	yes	no	none	none	none
10/09/05	KE	Esama sud	Manantenina	OP-60/014	--	D-well	--	--	yes	205	yes	no	none	none	none
09/09/05	KE	Mahatsinjobaky	Manantenina	OP-60/015	26/06/04	D-well	3.8	1.1	yes	96	yes	no	unknown	River	none
10/09/05	KE	Ankaramany nord	Manantenina	OP-60/016	07/07/04	D-well	4.9	3.1	yes	32	yes	no	none	none	none
10/09/05	KE	Ankaramany centre	Manantenina	OP-60/017	--	D-well	3.8	1.9	yes	140	yes	yes	none	none	none
10/09/05	KE	Ankaramany sud	Manantenina	OP-60/018	--	D-well	--	--	yes	--	yes	no	none	none	none
10/09/05	KE	Manambato bac	Manantenina	OP-60/019	--	D-well	--	--	yes	--	yes	yes	yes	River	Washing slab next to the pump platform
09/09/05	KE	Ampanibe	Manantenina	OP-60/020	--	D-well	--	--	yes	--	yes	no	unknown	River	Paddy field 5 m
09/09/05	KE	Ambalateza	Manantenina	OP-60/021	--	D-well	--	--	yes	--	yes	yes	unknown	River	River 15 m
09/09/05	KE	Tanambao centre	Manantenina	OP-60/026	--	D-well	--	--	yes	--	yes	no	none	none	none

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.2

Evaluation Format

Format used for data collection

RWSN

MEDAIR Evaluation Mission

Rapid Well Jetting Programme and Canzee Handpumps

Evaluation date:	Name of evaluator:

General Data					please fill in
Name of Organisation	MEDAIR Madagascar		Village / District		
Type of handpump	Canzee Handpump		Date when handpump was installed		
Handpump code No.			Handpump discharge (40 strokes per minute)		lt
Handpump is working well	yes	no	Number of pump users		households

Place (Environmental and quality conditions)					please tick or fill in
Is well sited neatly	yes	no	Any pollution sources near the well		
Well has run dry because of:					
Water quality is bad not acceptable because of:	Water has bad taste		Water has bad smell		
Water is turbid (silt, sand, other impurities)			Other reasons		
Other sources nearby (lakes, rivers, ponds etc.)			Well fenced	yes	no
Other comments:					

Product (technical aspects)					please tick or fill in
Was a jetting shoe used	yes	no			
Pump difficult to operate	yes	no	Low yield	yes	no
Frequent breakdown due to:	Handle problems		Pumprod problems		
	Footvalve problems		Sand intrusion		
What maintenance interventions have been undertaken since installation					
Other comments:					

People (Human Ressource Capacity)	please tick where applicable
What has the "Water User Committee" done since installation:	
Is there no trained Caretaker (missing training, Caretaker has left)	
Other comments:	

Promotion (Social issues)							please tick or fill in
Users opinion of water quality							
What is the water used for: drinking		cooking		bathing		washing clothes	
gardening		raising animals		other purposes			
Other comments:							

Additional notes from the evaluator:	
Signature of evaluator	

Evaluation of Rapid Well Jetting and the Canzee Handpump

Annex 7.3a

Photographs Manantenina

of all water points visited

Handpump Photographs Manantenina

Emanevy OP-60-002

Bekininy OP-60-005

Vohitrarivo OP-60-006

Manantenina OP-60-007

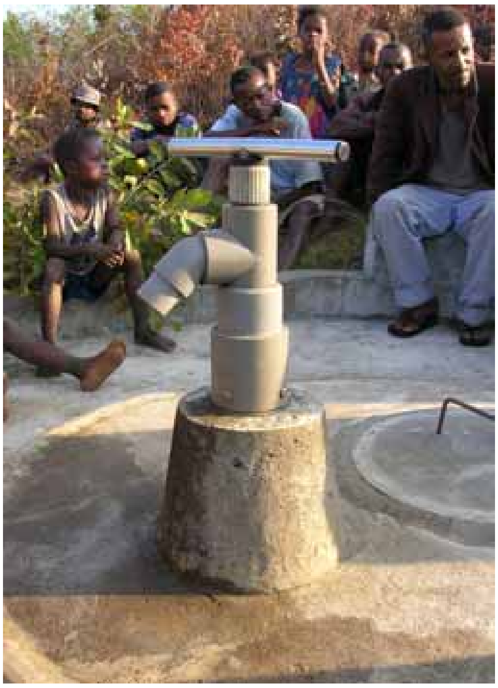
Manantenina OP-60-007

Mahantsara OP-60-008
excellent platform and fence

Mahantsara OP-60-008,
excellent platform and fence

Ampasimasay sud OP-60-011

Ampasimasay nord OP-60-009



Mahatsinjobaki OP-60-015

Esama sud OP-60-014

Ampasimasay centre OP-60-010


Ankaramany nord OP-60-016


Ankaramany centre OP-60-017


Ankaramany sud OP-60-018


Manambato OP-60-019


Ampanibe OP-60-020


Ambalateza OP-60-021


Tanambao centre OP-60-026

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.3b

Photographs Maroantsetra

of all water points visited

Handpump Photographs Maroantsetra

Andranofotsy AB 02

Andranofotsy AB 04

Andranofotsy AB 04,
worn handle

Andranofotsy AB 07/06

Andranofotsy AB 04, eccentricity,
(sign of a bent rising main)

Andranofotsy AB 07/06,
abrasion on pumprod pipe end

Andranofotsy AB 07/06, abrasion on pumprod and plunger

Andranofotsy AB 31

Andranofotsy AB 29

Andranofotsy AB 29, bent pumprod

Andranofotsy AF 08

Andranofotsy AB a

Andranofotsy AF 12

Andranofotsy AF 13, broken pumprod

Andranofotsy AF 13

Andranofotsy AF 14

Andranofotsy AF 15

Andranofotsy AF 20

Andranofotsy AF 19

Antoraka AT 02

Antoraka AT 01

Andranofotsy AF a

Antoraka AT 02, eccentricity (sign of a bent rising main)

Antoraka AT 03, general view, nicely kept well point

Antoraka AT 03

Antoraka AT 04

Antoraka AT 05, see washing slab in the background

Antoraka AT 10, too close to house

Antoraka AT 10

Antoraka AT 15, roof is detachable, see also washing slab (background)

Ambanizana AZ 01

Ambanizana AZ 01,
new handle (short version)

Ambanizana AZ 02/03

Ambanizana AZ 02/14

Ambanizana AZ 05/06

Ambanizana AZ 05/06,
handle worn

Ambanizana AZ 07

Ambanizana AZ 07,
worn handle

Ambanizana AZ 08

Ambanizana AZ 11

Ambanizana AZ 10/09,
handle worn

Ambanizana AZ 13,
extremely long handle

Ambanizana AZ 10/09

Ambanizana AZ 15/16

Maroantsetra, in town

Maroantsetra, inside prison,
pool of standing water (black) next to pump

Maroantsetra, near harbor
(abandoned pump)

Maroantsetra, outside prison

Maroantsetra, outside prison
thread of lower nut worn (see position)


Mahalevona MV 01


Mahalevona MV 02


Mahalevona MV 02, pump stand with red marks, (iron staining)


Mahalevona MV 03


Mahalevona MV 04


Mahalevona MV 05, too close to house

Mahalevona MV 09

Mahalevona MV 12

Mahalevona MV 13

Mahalevona MV 14

Mahalevona MV 18, clever handle repair

Mahalevona MV 18, too close to house

Mahalevona MV 22

Mahalevona MV 25, slipped pumprod joint

Mahalevona MV 26, hard to pump (pipes are scratching)

Mahalevona MV 27

Mahalevona MV 27, red staining on pumprod on inside of pump housing

Mahalevona MV 28

Mahalevona MV 29

Mahalevona MV 30, good fencing

Mahalevona MV 33

Mahalevona MV 32/34

Nandrahanana N 01, too close to house

Nandrahanana N 02

Nandrahanana N 03

Nandrahanana N 01,
pumprod broken,
(see short thread)

Rantabe R 01

Rantabe R 01, pumprod too long (see additional rubber washers)

Nandrahanana N 05

Rantabe R 02

Rantabe R 03

Rantabe R 04

Rantabe R 08, handle worn

Rantabe R 06

Rantabe R 08

Rantabe R 07

Rantabe R 09

Rantabe R 10

Rantabe R 10, pumprod too long (lowest position)

Rantabe R 11

Rantabe R 12,
handlewith strap

Rantabe R 13

Rantabe R 13,
handle rod too long

Rantabe R 14, re-glued
pumprod connection

Rantabe R 14, bad jointing

Rantabe R 14,
washing slab too close

Rantabe R 15

Rantabe R a

Rantabe R a

Rantabe R a, worn handle

Rantabe R b, nicely kept well point

Evaluation of Rapid Well Jetting and the Canzee Handpump

Annex 7.4

Terms of Reference

for the Evaluation Mission

MEDAIR humanitarian organisation humanitaire

MEDAIR Madagascar

Bureau National
Lot VV3bis, Ankaditapaka / Haute Ville
BP 6306, Antananarivo (101)
Tel. 22 363 92
Email: madagascar@medair.org

MEDAIR Madagascar

Bureau Règional
Rue de Gallieni
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Tel. 92 214 05
Email: madagascar@medair.org

Terms of Reference

Evaluation of rapid well jetting programme / Canzee pumps

Background

Since 2002, Medair has been working in the watsan sector in Anosy region. This 4 years project will end in 8 months. More than 60 new water points will have been constructed.
Moreover, in 2004, Medair implemented an ECHO and SDC funded cyclone-response project in the region around Maroantsetra, north-east coast, Madagascar. As part of a mitigation phase, Medair constructed 204 new wells, all equipped with Canzee hand pumps, using jetting as a drilling technique. This large number of wells was realized very rapidly, sometimes at a rate of 50 per week, during two separate jetting sessions in October and December 2004. Jetting has never before been attempted at such a scale and speed in Madagascar

In order to measure the success of this project, sustainability and long-term impact of the intervention, and to measure the potential of jetting for further (very) large scale emergency or development projects, an evaluation is proposed. This evaluation is expected to have two foci:

- technical evaluation of the CanZee pump and well jetting technologies, notably concerning impact assessment, cost effectiveness and appropriateness of the introduction of these new technologies in the project areas.
- long-term sustainability of the intervention, evaluation and reinforcement. The outcome will be used to rectify problems and to adapt the design of future jetting projects in Madagascar, with strong focus on long term sustainability of the constructions through active beneficiaries' participation.

Evaluation goals

The evaluation will focus on the following topics:

Jetting

- Technical evaluation of a representative sample of jetted wells, focusing on quality of construction and materials used, including type of apron, water quality, depth of the jetting (iron in the water table), predicted lifespan of the well, etc;
- Sand intrusion has been observed in a limited number of wells. This was found to be caused by some malfunctioning self-jetting shoes at the bottom of the wells, as well as slipped geo-textile wrapping around the well screens. Further wells were jetted without jetting shoes or sand intrusion was blocked using a plug. It needs to be investigated if the corrections carried out were effective and durable;
- While most jetted wells were implemented in rural villages, the evaluation should comment on the suitability of jetting in semi or peri urban settings in light of a possible risk of (chemical or faecal) contamination. Notably, this concerns the semi urban town of Maroantsetra where no form of clean water provision exists at all and thousands of shallow open wells are used. In town, the ground water table is high (between 0.2 and 2 meters) and open defecation is widely practised by

the 94% of people who do not own pit latrines. The soil consists of fine sands. Due to this uncertainty only a low number of wells were jetted by Medair in Maroantsetra town - the few existing wells however could be used to help evaluate the risks;

- Technical suitability of jetting for further interventions in Madagascar. The evaluation should comment on the suitability of jetting for additional (very large scale) jetting programmes in Madagascar in a development setting and the potential of the technique to significantly contribute towards achieving the MDGs for water in areas where the jetting is technically feasible. It should also comment on the potential of jetting for future private well installations. If the skills could become well established and easily available, it could make a very useful alternative to shallow well construction for (extended) family wells or for local institutions.

Canzee pump

- All important technical aspects of the Canzee pump need to be investigated. Despite the high potential of this pump, only very little documentation is available. The following criteria should be considered:
    - Quality of pump construction;
    - Appropriateness of the pump in combination with jetted wells;
    - Durability and robustness;
    - Expected lifetime (this might include a pump cycle test in a lab);
    - Suitability of materials used;
    - Cost-effectiveness of the pump based on current UK prices and likely reduction if manufactured in Madagascar, also in comparison with other pumps, such as the (locally produced) rope-washer pump, the India Mark III and Vergnet; what are the capital and ongoing costs when valued over 10 years?
    - Feasibility of local production of pumps and parts?
- Operation and maintenance:
    - Technical aspects: ease / complexity of maintenance and repair procedures reflected against the ability of the uneducated rural villagers;
    - Spare parts: are they needed and available? Can they be produced locally? Appropriateness of the pump for remote areas where there is no spare parts supply chain;
    - Future considerations needed to ensure long-term sustainability.
- Social perception of users (ergonomics, ease of operation, perceived value, feeling of ownership).

Programme methodology

- Validity of the very rapid project methodology. Despite the very rapid implementation, the project contained significant beneficiary involvement and participation. The low cost of a completed jetted well with Canzee pump allowed the construction of higher numbers of water points per person than normal (one well per 100 people / 15 families), facilitating semi-private family-group ownership. This is expected to improve ownership and the quality of operation and maintenance, by avoiding the pitfalls of community managed infrastructure systems. However, the pro's and con's of the Medair approach need to be clarified;
- Proposition of an alternative, more traditional, long term approach with the beneficiaries to empower them to manage the introduction of CanZee pumps and ensure long term sustainability. Notably through the evaluation of the introduction of CanZee in the developmental context in the south.
- Social issues and participation:

- Suitability and quality of the participatory process and methodology used for realising beneficiary involvement, within the constraints of a rapid emergency project, as well as suitability of the same mechanisms for developmental jetting projects;
    - Measuring the perception of ownership by well user groups;
    - Social aspects: measuring the technical ability of the well users to maintain and repair the pump (including their ability to produce spare valve flaps at village level);
- Identification of key success and failure factors relating to long term sustainability of the intervention, as well as recommendations for short-term actions that could improve long-term sustainability;
- Recommendations for an improved project methodology that can be applied during future very large scale and rapid jetting interventions, such as they are currently being prepared by CARE / Medair and which will feed in to the final "Rano Tsara" project proposal;
- Cost-efficiency of well jetting programmes in comparison with other more traditional methods for rural water provision in Madagascar.
- Prospect of the use of emergency relief in introducing a new technology which could be used in for longer term intervention. Ways to make the step from "relief" to "development".

Methodology

The Consultant is expected to interview staff from Medair Madagascar who were implicated in this project. This includes project management staff as well as local technicians. In addition, staff from BushProof will be available for discussing issues relating to jetting and the Canzee pump.Technical questions regarding the pump can also be addressed to SWS Filtration, the current UK based manufacturer.

On a national level, discussions might be held with representatives from the government[1] and NGO / donor community. In the field, observations and interviews are foreseen with (village) authorities, well users, etc. Well users can be requested to perform maintenance procedures in order to verify their ability. If necessary, Canzee pumps can be dismantled for inspection.

Medair will be able to perform well jetting demonstrations using their locally trained technicians and/or construct a well from scratch in a typical project site all within the evaluation period, starting from first contact with villagers to the completion of a fully equipped well. A final 'reunion de restitution' on national level might be organised in Tana for all actors and donors active in the water sector.

These terms of reference might be further refined, based on professional recommendations by the Consultant in order to make the final report as useful as possible.

Outcomes

The evaluation should produce the following outcomes:

- Evaluation report;
- Photo or manual illustrating critical technical and social success and failure factors.

To facilitate learning, a summary of the evaluation findings shall be presented to the actors involved with water and sanitation in Madagascar, for instance through a special session of the national WASH forum. An explicit purpose of this evaluation is to objectively present the findings regarding

[1] Consultation with national govt would be required to ascertain their attitude to the introduction of new technologies and non-standard pumps. If they are not supportive then the potential for large-scale programmes would certainly be affected.

the potential of large well jetting projects towards achieving the MDGs for water to a wide group of decision makers in the government, NGO and donor community.

Duration

The duration of the evaluation is expected to take between 2-3 weeks, with two field visits (Maroantsetra and Fort Dauphin) and the restitution in Antananarivo. This timeframe needs to be further defined and depending on the outcome of discussions with the consultant regarding time needed to achieve the ToR.

Conditions

Travel from Tana to Maroantsetra will by plane (Air Madagascar). In Maroantsetra itself good accommodation is available. However, many well sites are located in remote villages. Local travel might therefore include transport by vehicle, (motorized) canoe through inland waterways, boat trips over sea along the coast of the Masaola peninsula as well as on foot for several kilometres. Depending on the distance to selected well sites, overnight stays in villages might be necessary.
Medair has retained local staff experienced in well jetting in Maroantsetra, who can be mobilised to accompany the evaluation team into the bush and who will be available to discuss technical aspects and issues relating to project implementation methodology. A French-Malagasy translator can be provided.

The consultant

In order to carry out this external evaluation, a consultant needs to be identified who will meet the following criteria and skills:

- At least five years experience in undertaking evaluations and technical reviews of rural water and sanitation projects, both in an emergency and development context;
- Proven specific technical expertise in shallow and medium lift hand pumps, especially concerning sustainability and O&M issues;
- Excellent written and spoken French. Good spoken English. The evaluation report can be provided in either English or French.

Costing

A draft activity plan and budget are requested from prospective consultants.

Medair Madagascar.
Email: madagascar@medair.org

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.5

List of Abbreviations

and

List of Persons met

Abbreviations

ABS	Acrylnitril Butadien Styrol (a type of resistant plastic),
ANGAP	Agence Nationale pour la Gestion des Aires Protégées,
DAP	Direct Action Pump,
HIV/AIDS	Human Immuno-deficiency Virus/Acquired Immune Deficiency Syndrome,
NGO	Non-Government Organisation,
PVC-U	Unplasticised Poly Vinyl Chloride (plastic commonly used for water pipes),
SDC	Swiss Development Corporation,
SKAT	Swiss Resource Centre and Consultancies for Development,
MEDAIR	Organisation Humanitaire,
TARATRA	Organisme de Dévélopment,
Atelier T-Plus	Fabrication de la Pompe Rope,
WaterAid	Organisation Humanitaire,
BushProof	Organisation Humanitaire,
UNICEF	Fonds des Nations Unies pour l'Enfant,
MEM	Ministère de l'Energie et des Mines,
MSPF	Ministère de la Santé et du Planning Familial,

People met:

Mr. Christophe Roduit	Directeur National	MEDAIR	Tananarivo,
Ms. Fréderique Algret	Administratrice	MEDAIR	Tananarivo,
Mr. Andry Tianarivelo	Résponsable eau et assainissement	MEDAIR	Tananarivo,
Mr. Théophile Rabé	Field Team	MEDAIR	Maroantsetra,
Ms. Marie Petry	Coordinateur Entrainement	MEDAIR	Toalagnaro,
Mr. Benoit Girardin	Charge d'Affaires a.i.	Ambassade de Suisse	Tananarivo,
Mr. Adriaan Mol	Directeur Général	BushProof	Toalagnaro,
Mr. Régis Bejean	Chef Secteur de Maroantsetra	ANGAP	Maroantsetra,
Mr. Arsène Raveloson	Directeur Général	TARATRA	Tananarivo,
Mr. Alexis Randrianasolo	Directeur Général	Atelier T-Plus	Betioky
Ms. Dorcas Pratt	Directeur National	WaterAid	Tananarivo,
Ms. Dina Rakotoharifetra	Administrateur d'Adjoint de Programme	UNICEF	Tananarivo,
Mr. Victor Mafilaza	Ministère de la Santé et du Planning Familial	MSPF	Tananarivo,
Mr. Marcel	Ministère de l'Energie et des Mines	MEM	Tananarivo,

Local Authorities visited:

Mayor of Maroantsetra Town,
Mayors of rural communes in Maroantsetra District,
District Deputy-President,
Commune and Fokontany officials at Ambanizana,
Commune and Fokontany officials at Mahalevona,

List of villages visited in Manantenina District:

Ambalateza, Ampanibe, Ampasimasay, Ankaramany, Bekininy, Esama, Mahatsinjobaky, Manambato, Tanambao, Vohitrarivo.

List of villages visited in Maroantsetra District:

Ambanizana, Andranofotsy, Antoraka, Mahalevona, Nandrahanana, Rantabe,

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.6

Sealing Casing Pipes with Cement Plug

Detail of a SKAT Case Study

Information on Casing Seals of Cement

Used for sealing of casing pipes already installed. This technique was successfully used in Mozambique (CARE Mozambique) for preparing the installation of the Afridev Handpump with the Bottom Support System (cylinder setting up to 80 m).

Special comments for using this technique in connection of jetted casings for Canzee Pumps are given at the end of this information.

Manufacturing and Preparing of Casing Seal

In order to provide a secure and stable ground for the pedestal pipe, every borehole casing needs to be sealed at the bottom, before the pedestal pipe is placed.

The casing seal is made of a sack, which is filled with a dry concrete mixture (cement, sand and gravel or small stones).

This prepared sack is then closed and introduced into the casing pipe and placed at the ground of the pipe. When this sack is resting at the end of the casing pipe, water will slowly penetrate the sack through the holes and the concrete mixture will start to cure.

A) Manufacturing:

The ideal material to produce a sack for a casing seal is a PP or PE bag used for rice and other foodstuff or of jute bag. Out of a standard rice bag, one is able to make two casing seal sacks. Proceed as follows:
Flatten the bag and mark a line along the side of the bag, which is exactly 150 mm (for the 4” casing) from the outer end. Make a seam with a sewing machine along the marked line. The seam has to be strong and therefore repeat the sewing for at least three times. Then mark the second line from the other side of the bag and repeat the sewing procedure as described above. Cut the bag exactly between the two seams and one has now 2 long sacks. The sack needs to be turned over, so that the rest part of the seam is inside the sack.

B) Preparing:

The sack is now ready to be filled with the dry mixture of:

- 1 part cement
- 2 parts of sand and
- 3 parts of gravel (small stones, not bigger than Coca-Cola bottle caps).

This material has to be mixed thoroughly in dry condition and **make sure that no water is added!**

This dry concrete mixture will then be filled into the prepared casing seal sacks and when full, closed by a knot.

The sack looks now like a large “sausage” with its diameter slightly smaller than the inside diameter of the casing pipe and the length of the sack is about 600 to 700 mm.

Installation Procedures

Placing of Casing Seal

Before lowering the prepared bag into the well casing, please make sure that no sharp edge of a stone is protruding from the sack (to prevent the sack from being hooked on a casing pipe joint during his travel to the end of the borehole).

The sack can be dropped now into the casing and it will travel at first with a speed of about 2 m/ sec. and when it comes closer to the surface of the water, it will slow down and dive into the water with a very low speed (pneumatic effect).

Inside the water it will travel very slow to the end of the borehole with a speed of about 2 to 3 m/min.

Attention: This system should only be used after the installation crew has already experience in placing casing seals.

After about 10 minutes, the end position of the sack can be checked against the depth measured prior to placing the casing seal. For checking use testing weight B2418.

Fore safety:
In order to minimise the problem of a jammed casing seal bag inside the casing pipe, it is advisable to attach a small loop to the knot of the casing seal sack (made with a short piece of rope). Now the sack can be lowered slowly with the **"Fishing tool"** A2155 and disengaged as soon as the sack has reached the bottom of the casing. Should the casing seal sack pose problems during lowering by getting jammed at a casing pipe joint (due to a badly prepared sack), the bag can be retrieved again.

As soon as the sack has reached its end position, 2 to 3 kg of small stones have to be dropped into the casing pipe, in order to fill any possible gaps between the sack of the casing seal and the casing pipe and to provide a good support to the pedestal pipe.

The water will now enter the sack through the little holes and start to mix slowly with its content and create a solid block (casing seal). The curing time for the casing seal should be at least 12 hours. The pedestal pipe can be installed immediately after the casing seal has been placed, but the installation of the rising main should wait until the curing time of 12 hours is over.

Note: No casing seal is required if the lower part of the borehole is drilled in solid rock formations.

Using this technique for sealing casings for the Canzee Pump

If a jetted well casing pose problems with sand intrusion because the jetting shoe did not close properly, the sand can be blocked by a casing seal of cement.

Special comments:

- The dimension of the sack for the cement bag needs to be adjusted to the size of the casing pipe used. The filled sack needs 1 to 2 mm clearance compared to the inside diameter of the casing pipe, so that it can travel easily down the pipe.
- The length of the bag should be between 15 to 20 cm when filled.
- Checking the correct position of the casing seal is easy in short casings as used for Canzee Pumps. Proceed as follows:
    1. Insert the rising main pipe first completely until it rests on the jetting shoe and mark the position.
    2. Retrieve the rising main pipe and insert the casing seal sack.
    3. Insert the rising main pipe again and check the end position of the bag.
- Should the sack stop its travel for any reason, it can be pushed to its final position with the rising main pipe.
- Immediate well development as done with jetted wells (pumping of water with the jetting motor) should not take place, because the casing seal could be displaced. A curing time of several hours is required for the cement bag to be rigid in its place.

This technique was demonstrated in a newly jetted casing in Maroantsetra.

SKAT KE
09 2005

**Evaluation of Rapid Well Jetting
and the
Canzee Handpump**

Annex 7.7

Solvent Cementing Instructions

Detail of a SKAT Installation Manual

Instructions for Solvent Cementing of PVC-U Pipes

The principle of solvent cementing applies for all types of PVC-U pipes and PVC-U fittings that need to be connected.

Material and Tools required

1. Tools and Equipment

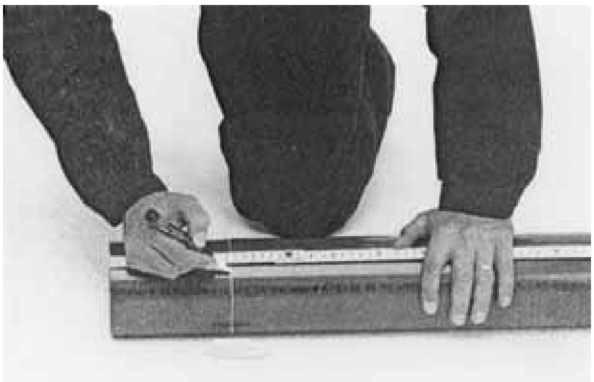
a) measuring tape	marking exact length and square cutting line,
b) pencil / permanent marker	marking prior to cutting,
c) hacksaw	easy cutting of PVC-U pipes,
d) pocket knife	deburring of inside edges (inside chamfering),
e) rasp or coarse file	chamfering the inside and outside edges,
f) sand paper 60 – 80 grit	roughening of jointing surfaces,
g) brush, flat 50 x 4 mm	for outside application of solvent cement,
h) brush, flat 25 x 3 mm	for inside application of solvent cement,
i) white absorbent paper	cleaning paper (or toilet paper),
j) small bowl (Bakelite or tin)	for easy application of solvent cement,

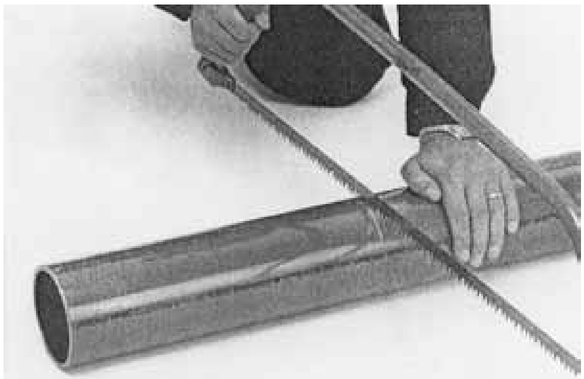
2. Material

a) Cleaning fluid	Carbon tetra chloride base,
b) Solvent cement	Tetrahydrofurane base,

Preparation of PVC-U Pipes to be jointed

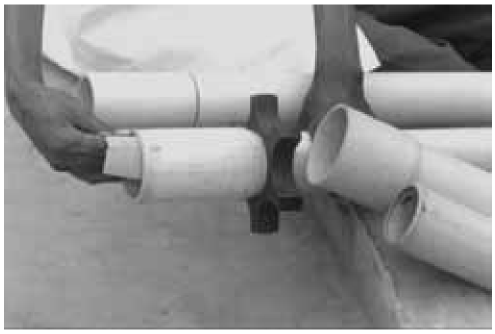
- Prepare a suitable working place not too far from the well point (place two logs for resting the pipes in a clean place above the ground), preferably in a shady place.
- Calculate all pipes needed for the required installation length.
- Place all pipes neatly next to each other on top of the two logs and clean all parts from dirt and dust.
- If one of the pipes needs to be shortened, mark the exact position (a line around the whole pipe) and cut along the line with the hacksaw, remove the burrs with a knife.





- Check all pipe ends for generous chamfer sizes; make chamfers if necessary with the rasp or a coarse file.

Note: 15° chamfers on bell-ends or sockets (inside) and on pipe ends (outside) are required and all sharp edges need to be rounded.



- All pipe ends (outside) and also all bell-ends (inside) need to be slightly roughened with sand paper until the surface appears matt.
- Then the roughened surfaces need to be cleaned properly with the cleaning fluid to ensure that they are free from any oil or grease (use a new paper with cleaning fluid as soon as any dirt is visible on the white paper).

- Let the cleaned surfaces dry for approximately 5 minutes and make sure that nobody touches the prepared surfaces with their hands.
- Clean the apron of the pump point, and prepare all the tools that are needed for the application of the solvent cement and the jointing procedure.

Note:

a) Well chamfered and rounded pipe ends prevent the layer of cement from being stripped off, as the pipe is inserted into the bell-end.

b) The mark of the jointing length (115 mm) on the pipe ends makes it possible to check afterwards whether the pipe has been inserted to the full extent of the bell-end.

c) The bell-ends of the standard pipes are slightly tapered and designed as such that the pipe cannot be inserted dry into the bell-end.
This will only become possible once the cement has been applied.

Do no attempt to make a joint that does not achieve an interference fit when dry.
This can be checked by inserting the spigot into the bell-end before cement is applied – if the pipe end (spigot) slides fully into the bell-end, it will not be possible to cement this joint satisfactorily, so this pipe should not be used here.

Important Information for Jointing PVC-U Pipes

1. Solvent Cement Jointing:

Solvent cement jointing (welding process) of PVC-U pipes offers a simple and quick means
of construction high integrity leak-free joints. Correctly made joints are stronger than the pipe itself. The solvent cement operates by chemically softening the outside of the pipe end (spigot) and the inside of the bell-end (socket). Joint integrity is greatly reduced if these surfaces are not absolutely clean and properly prepared.

This fact calls for adequate technical knowledge, clean working conditions and exact preparation procedures. The jointing instructions are intended to assist all those who are using this technique for the installation of PVC-U rising mains for handpumps.

2. Clean Working Condition:

As mentioned before, a clean working environment is necessary for receiving strong and leak-free pipe joint results. Without too much of a hassle, the working condition around the well point can be organised as such that clean working is possible. This includes:

a) placing PVC-U pipes on logs for preparing/cleaning of joints (in a shady place),

b) Cleaning material (Fluid & Toilet paper) and jointing material (solvent cement, bowl & brushes) in a shady, clean and dry place.

3. Organised Working:

Since it is of great importance that each jointing process has to be completed within a short period (recommended is 1 minute), the tasks of the installing personnel have to be organised.
In order to have sufficient time, it is advisable that the application of solvent cement is made by two persons, one for the pipe ends and one for the bell ends.

At least 2 people are required for pushing the pipes together.

One person is responsible for the time; he gives the command for staring of solvent cement application, for pushing the pipes together and for keeping the required curing time.

4. Excessive Applications of Solvent Cement:

Do not use excessive solvent cement when preparing for a new joint. A too thick layer of solvent cement will be scraped from the surface when the pipes are pushed together and will lead to a deposit inside the bell-ends. Large deposits inside the bell ends must be avoided as these can weaken the wall of the rising main pipe or might build up as much that the inside diameter of the pipe will be reduced and the plunger will not be able to pass through.

5. Curing Time for newly jointed pipes:

For any new pipe joint, a curing time of at least 5 minutes is required, before the next joint should be started.

Curing time for a completed rising main before pump is allowed to be operated:
It is essential that the whole rising main be allowed to cure for at least 6 to 12 hours until the
maximum load applied can be taken by the joints (operation pressure, weight of the water column and stretching of pipes due to oscillating movement during operation of the pump).

Installation Sequences for Rising Main or Pumprod Pipes in the Field

- Pour an adequate amount of solvent cement into the small bowl and apply a layer of cement to the interior surface of the bell-end with the smaller brush.
- At the same time apply a layer of cement to the pipe end of the next pipe to be jointed with the bigger brush.
- The brush strokes should always be in an axial direction.
- Ensure that both jointing surfaces are completely covered with a smooth and even layer of cement. (Application time should never exceed 30 seconds for each surface.)
- Bring the two pipes into position and push the bell-end **immediately** “in one go” over the prepared pipe end. **Don’t twist the newly inserted pipes anymore, as soon as they are pushed together.**
  During this strong pushing procedure, the pipes needs to be supported by hand, requiring at least 2 workers.
- Remove any surplus of solvent cement immediately with absorbent paper.

Tips for working with Solvent Cement:

a) Remove any skin, which may have formed on the cement in the tin.

b) Stir the solvent cement thoroughly.

c) Solvent cement should have the correct consistency. It should run smoothly from the bottle into the small bowel. Cement that no longer runs smoothly is unusable. Therefore never expose solvent cement to the sunlight and store it in a dry and cool place. (The same applies also to the cleaning fluid.)

d) Pour only the approximate amount of solvent cement into the small bowl that is used for the next joint and close the lid of the tin or the bottle immediately after pouring (to prevent the solvent evaporating).

e) When applying solvent cement to the inside of the bell-end hold the pipe horizontally and use the smaller brush. Work the cement in well with brush strokes in the axial direction until it forms an even layer.

f) Do not use excessive solvent cement and do not dilute or add anything to the solvent cement. Excessive deposits inside the bell-ends must be avoided as these can weaken the wall of the pipe.

g) Use a shelter to keep jointing surfaces dry in wet weather.

h) Clean the brushes and the bowl with dry absorbent paper after use. Brushes must be dry and flexible before being re-used.

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09 2005

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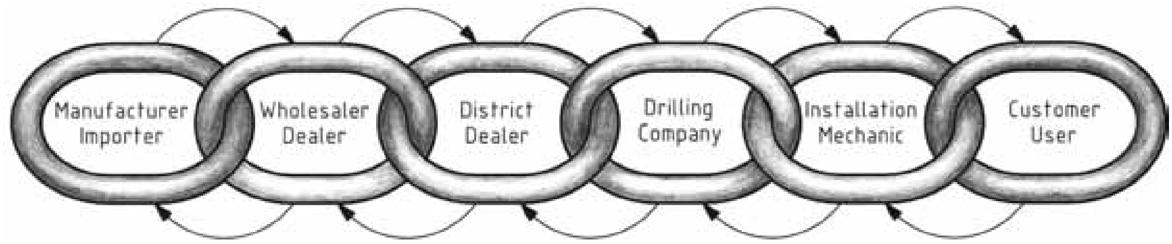
Annex 7.8

Supply Chain Example

A case study from SKAT Foundation



Supply Chain Issues for WES Facilities

Karl Erpf/Erich Baumann
August 2004

Supply Chain Issues for WES Facilities

Contents:

1 Introduction

The Millennium Development Goals for Water Supply and Sanitation have the ambitious goal to half the proportion of people without access to safe water supply and sanitation facilities by 2015. An estimated 1.5 to two billion people need to gain access to improved water facilities, 85% of these people live in rural areas. Millions of water points are necessary to serve those numbers. However, such vast investments can only reach their intended impact if the facilities are kept in working order.
In the past, goods and services were traditionally delivered by the public sector, with donors supplying spare parts and technical assistance through projects. Development projects have attempted either to channel spare parts and repair services through existing government departments or to set up parallel mechanisms associated with their own project support staff. In both cases, spare parts have often been provided free to users or with subsidies.
Despite best intentions, post-project problems of O&M management coupled with the common inability to reach outlying poor rural areas, put supply chains management issues at the core of sustaining investments. Delivery mechanisms for spare parts and repair services have consistently failed because of limited resources, and a lack of incentives, resulting in a high percentage of non-functioning handpumps and water systems only a few years after their installation. This is a problem particularly acute in Sub-Saharan Africa.
Poor quality of construction and non-affordable systems also contribute to neglect of routine O&M and non-allocation of funds for it. Adoption of cost efficient technology solutions needs to be coupled with functioning O&M.

2 Background

Experiences from the last decades showed that technical maintenance alone cannot solve all problems. The whole approach has to be tackled in a comprehensive way, which RWSN summarizes under the term “Supply Chain”. In their simplest form, supply chains transform raw materials to products, which are sold to customers. Payment for this process flows in the opposite direction in the chain.
In rural water supply and sanitation, goods and services (equipment, training, repair services, financial and technical services, and facility management) have to be supplied through a supply chain from manufacturers, importers, and service providers through a network of distributors to the users.
The need to subsidise the investments for water systems makes the setting up of supply chains complicated. Project centred procurement is often at the core of broken down supply chains. The projects purchase on behalf of users. International importers supply the equipment, and the economically not lucrative sales of spares should be taken up by the local private sector. Buying directly abroad short circuits the essential lower links in the supply chain thus impedes the capacity of local spare parts dealers to support water systems.
The availability of spare parts is influenced by a number of inter-related factors including market size and segmentation; equipment standardization; existing base(s) for equipment; spares manufacture; efficiency of after-sales support; and the policy on involvement of informal service providers.
The underlying objective of a functioning and sustainable supply chain is to deliver a successful product to the customer, and all involved stakeholders make an acceptable profit. There has to be a demand for a product that:

- available;
- affordable
- of adequate quality; and
- delivered in an appropriate time.

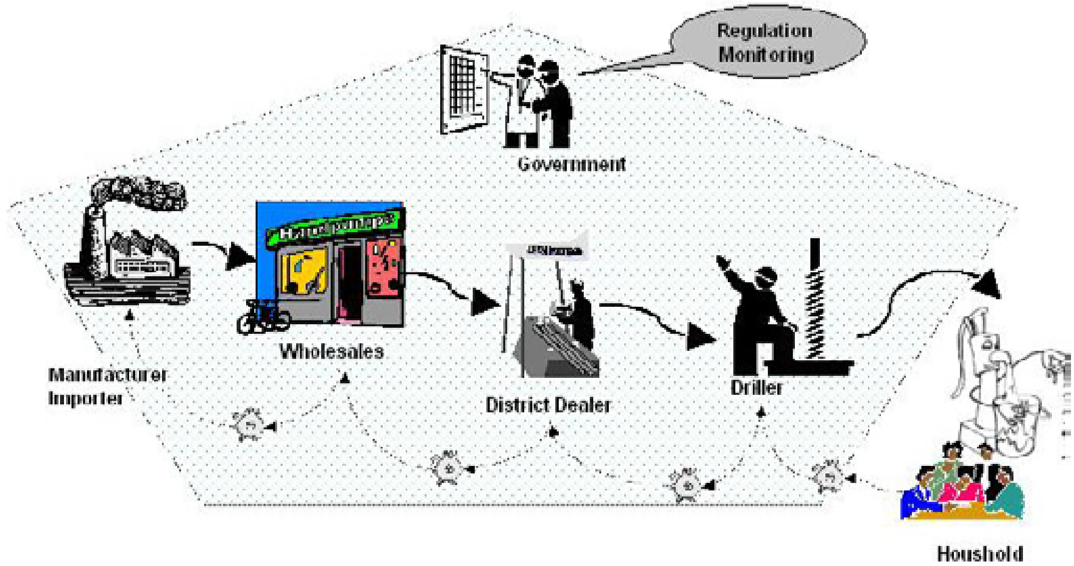
Benefits have to satisfy both the suppliers as well as the customers. There is no doubt successful supply chains have their costs, “cheapest” is not always “best”. Using commercial networks for supply of equipment and spare parts might mean that the goods may be a few dollars more expensive. However, in order to achieve sustainability for the built facilities, investing in the development of independent and sustainable private sector suppliers is money well spent and worth its outlay.
A paradigm shift is needed on part of all implementers of projects; emphasis has to be placed on setting up mechanisms to work with and through the local private sector.

In the past, project procurement officers were the customers. The suppliers focused primarily on delivering the goods to the warehouse and this point their responsibility ended. They had no relationship with the end users of the products. Accordingly, suppliers were not bothered about after sales services. When supply chains go right down to the users the suppliers must to collaborate with dealers, mechanics and the customers to meet their requirements through product availability and responsive delivery. In such a relationship, there is an equal importance to information flow and financial flow amongst all stakeholders. Therefore the supply chain performance must not only measure how well the services are provided to the customers but also how the financial aspects are handled between stakeholders.

3 How does a Supply Chain work

Supply chains start at the raw material stage and are a process that adds value to the products in several steps until the products are sold to the customers. Payment for this process flows in the opposite direction of the chain.

3.1 Flow of Services and Finances



In the RWS sector, a possible supply chain exists from manufacturers, importers, local and regional dealers, service providers (repairers, installers, trainers, etc) to the customers (water committees, individuals, etc) for goods and services (equipment, training, repair services, financial and technical services, and facility management).

It should be noted that for more complex water facilities (motorised systems for small towns) the customer is often well defined. It is the operator of the system. For low cost, handpump based systems the client is frequently not well defined. Community based O&M allows for heterogeneous institutional arrangements in O&M management.

Therefore, the lower end of the supply chains becomes somewhat vague and no proper structures are set up.

The basic objective of all supply chains is to deliver a useful product at an acceptable profit at all levels. Benefits in the supply chain have to satisfy both, profitability for the suppliers as well as customer satisfaction.

In many countries (and especially in Africa), the situation is not always favourable. Geological and economic conditions make it difficult to provide safe water to rural houses. The flow of goods and services to rural areas is made difficult by:

- manufacturers of equipment may be distant from users, often, when the equipment is imported, they are based in other countries;
- the distribution (retail) market may be poorly developed;
- communication and transportation links are poor; and
- customers are isolated and poorly informed, and little is known about their demand.

An additional obstruction is the need to establish mechanisms to subsidise the construction of water systems, which makes the setting up of supply chains considerably more complicated.

Stakeholders, particularly those in government agencies and NGOs, feel that they should meet basic human needs, often through the direct provision of heavily subsidised services.

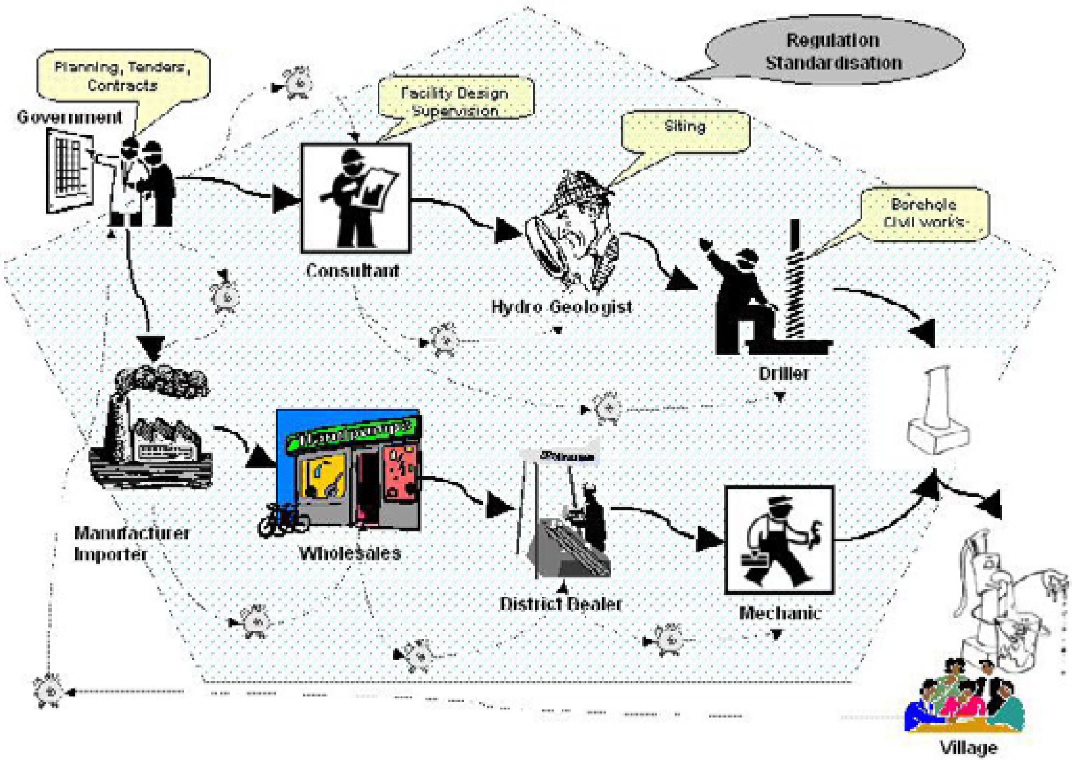
NGOs often believe that using the market approach, with greater private sector involvement and the proper use of existing commercial networks is unacceptable, as the aim for profits in the private sector is at odds with the needs of the rural poor.

3.2 More complex Supply Chains

In rural water supply, the complexity of supply chains can vary considerably. In a simple supply chain (as shown above), the customer's demand is the only driver and the role of the government is only to provide an enabling environment.
More complex facilities, with complicated technology and more players involved, have usually higher costs, which are too high to be affordable for a single household or a rural community.
In such supply chains, there are basically two drivers:

- The Government or the donor project
- The Community

The contribution of the community is supplemented by a (often heavy) subsidy from the government or the donor project. Money is mainly flowing "top-down" in the chain and not "bottom-up". The communities, for whom the WES facilities are built for have no direct control what is happening to their contribution – **they are not the customers**.
Special attention is therefore needed to make sure that the end users are included in the supply chain.



4 Business Approach to successful Supply Chains

Five key factors are essential for a successful **"business approach"** in a supply chain:

4.1 Adequate Demand

A continued demand for the goods and services, which are provided through a supply chain, is **the fundamental factor** for the sustained operation. Specific factors are important to generate such product demand. They include, primarily, the felt need for safe water supply and sanitation services by the users.
A supply chain only exists in response to customer demand. Without adequate demand, a supply chain will not develop and function sustainable. In complex systems, the operators (who might be running the systems on commercial basis) express the demand more explicitly. In community-based maintenance, the demand is often not so clearly articulated.
Development of self-supporting, sustainable markets with a continued demand for water supply and sanitation products (e.g. new equipment, spare parts and repair services) is not necessarily created

by projects despite the fact that they might be the biggest buyers. Their interventions often have a distorting effect on the market. Project procurement does not reflected demand, and is detrimental to the creation of viable private sector markets.
Cost for investment and maintenance, appropriate products, simplicity of the technology are other important factors.

4.2 Effective Stakeholder Incentives

For the private sector to stay involved in business as a link in a supply chain, the suppliers must have sufficient motivation and confidence that the products offered will yield enough profit to make the initial investment and the continued effort worthwhile.

4.3 Effective Information Flow

To create and maintain the supply chain there must be adequate information flow between stakeholders, and improved communications. Customers need to know where they can get the products. Suppliers need to be aware of long-term policies and strategies in order to invest into the access to the market.

4.4 Effective Supply Chain Management

Useful supply chain management means to intervene as little as possible but to build effective relations between stakeholders, to identify and develop potential partners in the chain, to make partners aware of the 'bigger picture' and to create a collaborative environment for planning.

4.5 Enabling Environment

Policies of Governments, Donors, and NGOs should create an enabling environment, which does not inhibit the markets. Enabling environment also means stability of the market. Entering a market requires an investment, which should have a reasonable rate of return. If the prospects of staying in the market are short, the investment costs need to be recovered in this short period.
All of these additional factors are mutually important for a successful supply chain and there are many linkages between them.

4.6 The 5 P’s in the Business Approach

The establishment of consumer demand for any given product depends on five key criteria:
Product - the product achieves its intended utility and purpose and is of adequate quality for the consumer.
Price - the product is available at an acceptable price to the consumer.
Place - the product is available in adequate volumes in the required location.
Promotion - consumer knowledge about the use and benefits of the product, and information where and how it can be acquired and maintained.
Policy – policy creates an enabling environment that allows the private sector to function with as little restrictions as possible and at the same time protects the customer’s interest.

4.6.1 Product

A product must fulfil its intended purpose in order to create and sustain consumer demand. Product quality and reliability affect consumer demand. Poor consumers are not always willing to pay for quality improvements; often a compromise between price and quality is made. They might opt for the cheaper, less reliable technologies.
The product should be straightforward enough for people to understand how to use and repair it. If the technology is beyond the understanding of the customer, he might not attempt to repair it when it breaks down.

4.6.2 Price

To stimulate and sustain demand, the cost of a product must be within acceptable limits to the consumer. Ability and willingness to pay is a function of the added value the customer expects from the product and on the cash, he has on his disposal.
Low cost technologies can stimulate and sustain a demand from individual families or from small communities. Affordable, simple technologies can be produced near the users and allow therefore to establish short and uncomplicated supply chains.

Expensive, complex products have more players in the supply chain who need to make a living from selling goods or services. The components have to travel greater distances increasing the cost and thus having an adverse effect on demand.

4.6.3 Place

It may not be profitable if, as is the case in sub-Saharan Africa, private sector suppliers have to travel large distances, often on bad roads, to deliver products, perform maintenance and make repairs. The number and the density of customers per location is critical, they have a strong influence on the viability of business. Successful supply chain examples in South Asia usually profit from high population densities, which allow SME to operate due to short delivery distances and close suppliers. The availability of goods and spare parts is influenced by a number of inter-related factors including market size and segmentation; equipment standardization; existing production or utilisation base(s) for equipment; spares manufacture; efficiency of after-sales support; and the policy on involvement of informal service providers.

Development projects have the tendency to install large volumes of equipment in their project areas; all need to be supplied with after sales services. This project centred approach with little co-ordination between project of other implementing agencies results in a variety of small, limited and unsustainable markets for different technologies. Standardisation has the potential to create sufficient levels of demand for supply chains and viable markets. However, standardisation is an intervention by government, which interferes with free markets. Therefore, decisions to standardise should be well considered.

4.6.4 Promotion

To stimulate and increase demand, potential consumers need to have enough product information, such as the utility and benefits, the specific properties and qualities, as well as how it can be purchased.

In rural water supply, the promotion of products had traditionally been centred on intangible health benefits. Users often do not understand health as the main reason to invest in clean water, which means they have no motive to pay for maintenance. If water supply can be seen to have an economic benefit, it might be easier to motivate the customers to invest in keeping the systems operational.

In future it could be important to look at other ways of motivating people to believe that water is an essential commodity i.e. some social marketing might be necessary.

4.6.5 Policy

The business environment in supply chains operate should have secure macroeconomics, open trade, and unbureaucratic financial and fiscal sectors. When these aspects are not well-developed the private sector may be reluctant to invest and establish itself on a long-term basis.

Governments and ESA can create effective support mechanisms for small local enterprises to get access to finance. They also can create regulation mechanisms that are conducive to improving the environment in which to do business.

Often the local entrepreneurs are in distinct disadvantage towards the projects and NGOs because the tax legislation forces them to pay import tax and duties. In addition, they often might have to compete against state monopolies and they are hampered by interventions in pricing and distribution. Good infrastructure is also vital for business. Good roads and reliable communications reduce the costs and simplify cash flow management.

5 Problems and Challenges

Procurement/buying at factory level: In project-centred procurement, each project purchases its own equipment where it deems best and according to its own rules. Thus, suppliers have no market continuity and therefore only produce or import the specific equipment that is needed for the particular project. Buying directly abroad "short-circuits" the essential links in the supply chain. It deprives the intermediate traders and contractors of their income and in turn impedes their capacity to support water systems with after sales services.

De-linking supply of equipment from supply of spare parts: Generally, sale of spare parts only is not economically viable. Suppliers of spare parts are not interested in the business.

Separating supplies into different sections: Often the provision of goods and services is split up into various individual components. Instead of forming a chain, a conglomerate of parallel links is built. The suppliers are not linked but independently managed through a project. Thus, the accountability of the specific suppliers is reduced to the particular delivery. He has often no connection to the users.
Separating the customer from the supply chain: If the users have no say in the procurement of the equipment and are passive beneficiaries of received aid (heavily subsidised and/or free pumps or latrines), they are not part of the supply chain and cannot create a fruitful customer-supplier relationship. The facility is used for a while and later abandoned because nobody knows where or how to get repairs/replacements.
Give-aways or subsidies: This distorts the market and at worst can keep the lower links of the supply chain inoperative.
Non-affordable technologies: When high cost technologies are promoted, users are grouped into larger user communities to make the technology affordable (with all the social and management implications), rather than first seeking affordable solutions.
Neglecting the importance of legal ownership: (This applies especially to community facilities). Ownership does not start when a water system is "handed over". It is essential to create the full control through those who run the facility.
Promotion of community solutions: Because it is easier to control the construction of sizeable facilities than individual solutions, projects prefer to implement community water supplies also in areas where the customers would prefer household solutions.

6 Focus

The focus of RWSN work on supply chains is on optimising the relationship between "usefulness-sustainability-quality-cost-affordability". The prerequisite to buy equipment (handpumps, latrines, etc.) at the cheapest source needs to be reviewed. Using existing commercial networks could result that handpumps, equipment and spare parts may be more expensive. However, supporting independent and (often indigenous) sustainable private sector suppliers is money well spent.
The following points are considered when supply chains are studied:

- Commercial networks in rural areas exist in most countries to some extent for soap, agricultural material, alcohol, vehicle parts, and other products.
- The challenge will be to utilise such existing commercial networks in a way that supply of water equipment is a profitable business. Each level of the supply chain should benefit sufficiently to ensure sustainability.
- Water systems and latrines should be sold in such a way that the customer (individual households or communities) has one answerable supplier to deal with.
- Market forces apply to supply chains! It is unlikely that a supply chain will function with products that are not affordable, spares that are too expensive or a volume-profit relationship that is not favourable.
- Supply chains cannot function for single projects; they have to serve the whole sector. Coordination among all stakeholders is needed for setting up supply chains.

Following the above guidelines will eventually lead to policy changes at government and donor level. It might result in paying a higher price for the product, particularly in remote areas where the commercial network is weak. This is, however, a small price to pay for sustainability and to avoid the thousands of broken down or abandoned water systems worldwide.

7 Objectives and Methodology

7.1 Objectives

The RWSN is formulating a Supply Chain Strategy, which will work out guiding principles and recommendations for the setting up of sustainable supply chains for equipment and services for rural water supply.
It will produce tangible tools for decision makers, project planners and implementers on key issues, such as:

- Establish the principles that encourage the successful private sector participation in supply chains,
- Creating an enabling environment that allows local commercial networks to operate successfully

- Develop strategies and action plans for project implementation (decentralised implementation as well as traditional projects) that takes into account the principles of valuable supply chain development
- Identify potential interventions that can be used as “booster” to help establishing supply chains

7.2 Methodology

The methodology will be to uncover good practices to deal with critical aspects through a series of country cases studies. Over the next two years, the RWSN will carry out policy support and guidance on supply chains in several focus countries (Ethiopia, Mali, Mauritania, Benin, Mozambique, Tanzania, Uganda, and Malawi). In all these countries, the approaches cannot be standardised. New and innovative methods of management need to be developed that are adapted to the local conditions and social behaviours.

7.2.1 Comparative Study of Supply Chains

RWSN developed an analytical framework with checklists of the type of data that needs to be collected and a methodology on how the data is evaluated on different type of supply chains. At present, “Desk Review” studies of established supply chains for providing goods and services through the private sector have been conducted in four countries:

- Mali (water supply systems in ST and large villages) and CCAEP
- Mauritania Total Warranty on solar water supply system and ANEPA
- Benin spare parts and services for hand pump
- Ethiopia

Similar studies are already planned together with UNICEF Mozambique and UNICEF Nigeria, in which RWSN will asses the existing supply chain experiences.
The comparative study tries to give answers how to set up functioning supply chains. It developed an analytical tool as a new way of examining existing projects as well as proposed programmes. This tool aims to ascertain whether the interventions strengthen or weaken the supply chain; and whether the environment is suitable for a supply chain to function.
The use of the **Assessment Tool** should be followed by formulating ideas and actions to improve the system, using validated lessons learned, and providing an overview of the potential for establishing effective lines of supplies, highlighting the following issues:

- Principles around the dynamics of product / market creation,
- Findings for generic recommendations for a "business" approach to serve the poor,
- Reflection on the five «Ps» (Product, Price, Place (in the market), Promotion, Policy (national policy& regulation sector strategy that impact on the chains),
- Role of the agencies/NGOs/firms,
- ESA policy and procurement regulation,
- Sector policy, procurement regulation and sector strategy that induce attractive and competitive market and cost reduction,
- Boosters to create a “Supplier-Customer” relationship between the supplier and the end-user.

A **Decision Support Software** will be developed to provide the methodologies to structure decision trees and influence diagrams, and to analyse data in a computer supported decision-making aid. This decision support software will help to make precise, objective, and completely supportable decisions - even for complex problems involving many criteria and alternatives.
The work will outline an approach how develop and prepare tangible guidelines for setting up successful supply chains, with principles to be followed and recommendations for institutional structures.
The results from these efforts together with similar initiatives by other organizations will provide the basis for a synthesis on issues and options concerning the development of effective supply chains. The study will also draw on relevant work concerning:

- Other rural infrastructure (roads and transport, energy etc),
- Local stockists and repair shops for agricultural input and equipment and
- Rural finance and micro-credit services.

A special session of the TECHFEST workshops will be dedicated to Supply Chains for Community Water Services and will be based on the country case studies. This session and the preparatory work will yield a better understanding of the various factors (technical, social, financial, institutional and policies) affecting the development and the operations of supply chains for community and household water services. The study will identify topics for further learning and for the preparation of guidance material. The ultimate objective is to develop model systems for procurement policies and

for O&M that are replicable. The study will also foster exchange and dissemination of best practice in supply chains management.
The systematic approach will also draw in the Government authorities and donor community into a dialogue on procurement and mechanisms to channel funds. It will focus essentially on the policy and the institutional environment and on expanding the capacity of existing commercial networks (stockists, traders, etc.).
Existing documents on supply chains are generally directed at the dissemination and widespread adoption of a specific technology; e.g. Treadle pumps in Bangladesh, Rope pumps in Central America. However, the goal of the studies on supply chains is not to promote a particular technology but to create the necessary understanding for generic supply chains (handpumps, motor pumps, latrines, etc.).

7.3 Expected output

The RWSN Supply Chain Initiative will provide an expert synthesis of knowledge on critical factors promoting effective and efficient supply chains and procurement systems for RWS in Africa/Asia and the dissemination of related guidance material (supply chain studies, workshop synthesis document and dissemination materials) to assist application of best practice approaches.
It will propose criteria for strategic decision-making and offer a perspective for more affordable and sustainable rural water supply services through better partnership between the private and the public sector. The working together of all stakeholders will lead to effective market creation through implementation and operational practice that will be conducive for setting up effective supply chains. In a number of countries, which have participated in studies and applied the findings and recommendations, knowledge will be generated of best practices and this knowledge will be translated into operational guidelines for Implementation.

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.9

Hand Sludging

A Report from North West Bengal
by
Peter Ball and Kerstin Danert from Cranfield University Silsoe

HAND SLUDGING

A REPORT FROM NORTH WEST BENGAL

Peter Ball and Kerstin Danert

March 1999

an internal report of the Low Cost Drilling Project
of Cranfield University (UK), funded by DFID,
in partnership with Government of Uganda,
Danida, Sida, and Unicef

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Reference as: Ball, P and Danert, K (1999) Hand Sludging: a Report from North West Bengal. Report of DFID KAR Project R7126 “Private Sector Participation in Low Cost Water Well Drilling”, Cranfield University. ISBN 1861940 548

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FIGURES

ABSTRACT

The Low Cost Drilling Project (Cranfield University/DFID/Government of Uganda) is developing a modification of the traditional Asian sludging technology for use in Africa. As part of the technology research a visit was made to north India to observe and measure various characteristics of this well drilling technique. The report describes these observations and draws conclusions for the Low Cost Well Drilling Project.

The method and equipment used by the Indian drillers ("mistries") are set out, followed by an outline of the ergonomics and quantification of the work rates needed for hole cleaning and drilling. Drilling penetration rates in soft alluvium were observed to range from 16.5 to 45m per hour.

Traditional and more modern designs of casing and wellscreen, and the corresponding well completion methods, are described.

The cost of a 12m water well drilled by sludging in North West Bengal is estimated at Rs200 (approximately £3-4).

Practical conclusions are drawn in relation to equipment design for Uganda or elsewhere in sub-Saharan Africa.

ACKNOWLEDGMENTS

The Project is funded by the UK Government Department for International Development (DFID). The Project operates in partnership with the Government of Uganda Directorate of Water Development through the Water and Environmental Sanitation (WES) Programme, funded jointly by GoU, Swedish International Development Assistance (SIDA), the United Nations Children's Fund (UNICEF), and the Government and People of Uganda. All these linkages and funding sources are gratefully acknowledged.

The Project Team consists of Dr Richard Carter (Project Manager), Eng Kerstin Danert (Research Engineer), Mr Peter Ball (Drilling Consultant), Mr Ezron Rwamwanja (Community Water Supply Specialist), and Mr Jamil Ssebalu (Small Business Specialist).

BACKGROUND AND INTRODUCTION

This report discusses the technique, equipment and cost of the traditional human powered drilling method known as sludging. The information was collected on a visit undertaken by Mr Peter Ball to Cooch Bihar in North India in December 1998.

Sludging, also known as Bangladeshi Sludging, or slugging is a traditional drilling technique which is commercially entrenched in North India and Bangladesh, and practised by ‘Mistries’. The Mistries are local tradesmen who have learned the process and own their own drilling equipment. They are employed to drill holes for domestic water supplies, which will use No 6 Type cast iron hand pumps and irrigation tubewells operating with treadle footpumps to 3” diesel pumps.

Visit Itinerary

22nd Dec 1998	Depart London for Delhi - plane diverted to Bombay due to smog in Delhi
23rd Dec	Arrive Delhi p.m. and visit IDE to discuss arrangements for trip to West Bengal
24th Dec	Travel to West Bengal - flight delayed due to fog in Delhi
25th Dec	Arrive to meet IDE local personnel and drive to Cooch Bihar - tubewell drilling district
26th Dec	Visit drilling sites near Cooch Bihar
27th Dec	Visit more drilling sites around Cooch Bihar
28th Dec	Visit hardware shops selling tubewell materials and tools and travel back to Delhi
28th Dec	Return from Delhi to London

THE SLUDGING METHOD

Two Mistries operate the rig as shown in Figure 1. The skilled practitioner has one hand on the pipe and utilises the other as a flap valve. He also takes the samples. The junior or employed crew operates the lever.

Figure 1: Mistries Operating Sludging Equipment

The hole is kept flooded to ground level throughout the drilling operation. The cuttings are removed with the water by the flap valve action of the operator's hand on the top of the hollow pipe. When the pipe is raised, the hand covers the top of the pipe, holding the water in suction and lifting it with the pipe. As the pipe starts to descend, the hand is raised and the water containing the cuttings ejects out of the top (Figure 2), thus, the percussive action is used to both drill and clean the hole. The flooded hole ensures that the suction head on the top of the drill pipe is kept to a maximum of 1.5m.

Figure 2: Sludge Ejecting from the Pipe

Good general hole construction technique is practised by the Mistries observed in Cooch Bihar. A shallow pit, which was kept filled with water throughout the drilling process had been dug at all of the drilling sites visited, enabling the cuttings to settle. Losses into the formation were anticipated, and reduced by adding small quanties of cow manure into the annulus to seal off zones with lost circulation. The Mistries kept the hole under construction flooded in order to exert hydrostatic head down the borehole and prevent hole collapse. The water required was fetched by the client farmer, who accepted this as an essential job to be undertaken. Note that during the visit, there was still plenty of pooled surface water available from the previous rainy season.

The Mistry holding the drill pipe, would, on occasion twist the drill pipe approximately 1/8 to 1/4 of a turn it descended. The twisting action was undertaken for approximately 50% of the stroke, with the other strokes descending without any rotation.

Observations in India showed that the percussive action occurs at a mean rate of 1.75 strokes per second, (105 per minute) with the operators speeding up or slowing down to remain comfortable. The stroke length varied between 0.2 to 0.5m with a mean of 0.4m.

EQUIPMENT

The equipment used in Cooch Bihar, as shown in Figure 3, comprises a water pipe which is raised and lowered in the hole by means of a lever. The pivot is a single bamboo rod positioned 0.5m from the borehole axis. The lever is up to 2m in overall length. When drilling deep holes up to 30m, the fulcrum remains the same but more men operate the lever.

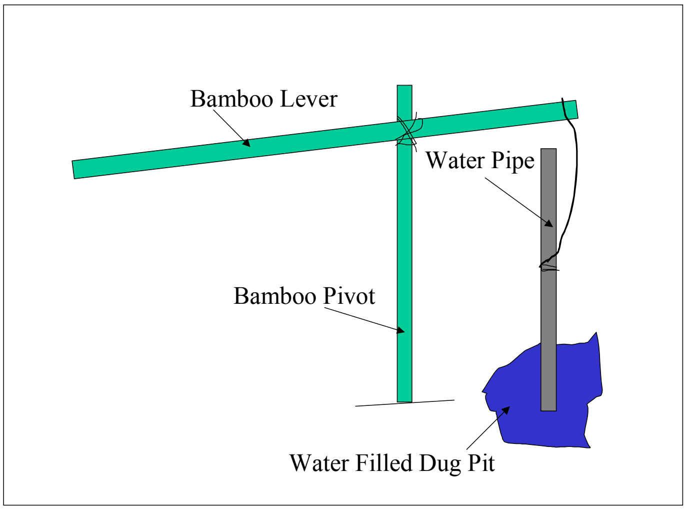

Figure 3: Sludging Equipment

Drillpipe

The drillpipe is universally 1½" tube, which may have originally been galvanised but has subsequently worn black. 1½" couplings are used to connect the pipes. The Mistries observed in Cooch Bihar used 3.1m (10') pipe lengths. A 1.5m (5') piece was used alternately at the surface to enable the mistrie hand sludging to remain comfortably on the ground, squatting as the pipe drilled into the ground (Figures 4 and 9). This differs from the bamboo structure, which has been observed in use by other Mistries.

Figure 4: Mistry Starting a Hole with 1.5m Pipe

The use of 1.5m pipe at the surface avoids the need for such a structure and may maximise the efficiency of the sludging technique by ensuring that the maximum suction lift is limited to 1.5m. The pipe measured 48.5mm OD x 40.4mm bore having a weight of 12 kg for a 3.1m length.

Drill Bit and Drive Shoe

The 'drill bit' (Figure 5) is a standard 1½"x 2", 3" or 4" reducing coupling. On larger sizes, the lip is internally bevelled to making a cutting edge. Generally holes only just bigger than the screen OD are cut.

The drill bit also acts as a drive which may be crucial to obtain the flow of slurry up the drill pipe. The drive shoe has a tight fit in the hole and probably forces the water into the drill pipe as the pipe descends.

Figure 5: Drill Bit

ERGONOMICS

The lever operator raised and lowered the lever with his hands. When drilling, the operator regularly changed the position of his hands and height of his arms in order to remain comfortable. The valve operator starts off standing at the drill pipe and bends over as the pipe penetrates the ground until he ultimately ends up squatting.

CLEANING

The lever mechanical advantage when cleaning is approximately 3:1. Thus the lever operator must exert a force of 108N to lift 10m water filled pipe length. During the cleaning process, the mean stroke rate was 0.8 strokes/second, with a stroke length of 1m. Thus the operator is working at a rate of approximately 86 watts. This is just above 70W, which is considered to be a comfortable rate for an adult to work at continuously. Figure 7 indicates the power requirements of the lever operator(s) for different pipe and stroke lengths.

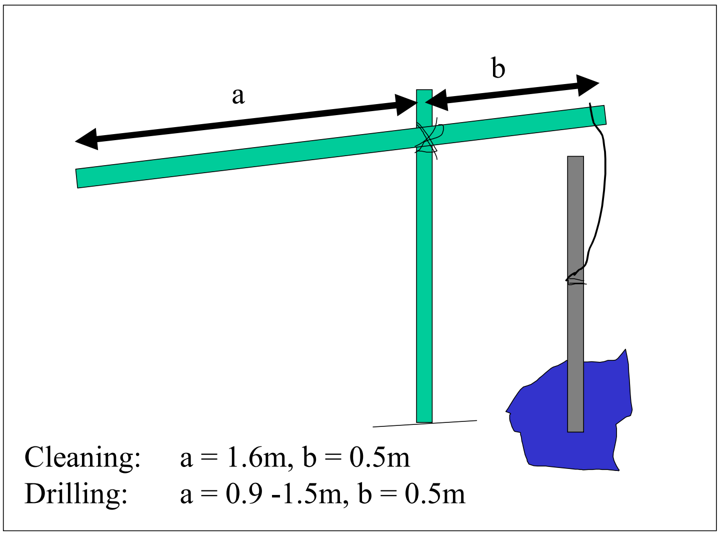

Figure 6: Observed Structure Dimensions

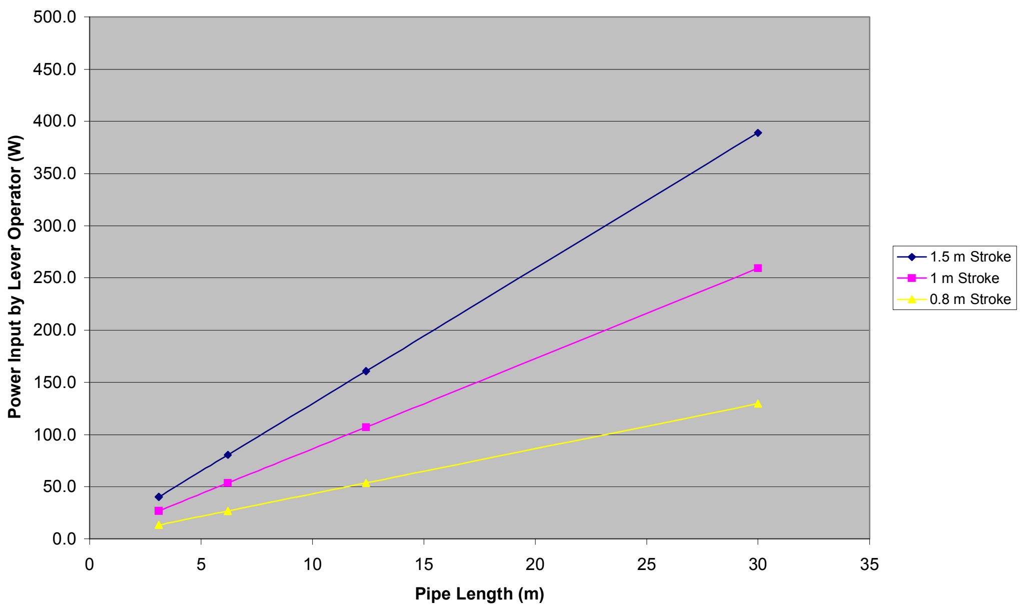

Figure 7: Power Requirements for Lever Operator when Cleaning at 0.8 strokes/s

DRILLING

The lever mechanical advantage varies from approximately 2:1 to 3:1. Taking a ratio of 2:1, the lever operator must exert a force of 160N to lift 10m water filled pipe length. The stroke length varied from 20 to 50cm with a mean stroke rate of 1.8 strokes/second. Assuming a stroke length of 0.4m, and mechanical advantage of 2:1, the lever operator must work at a rate of approximately 120W for a 10m-pipe length. Figure 8 indicates the required power input by the lever operators and illustrates why it is necessary to have more than one operator, as the wells become deeper.

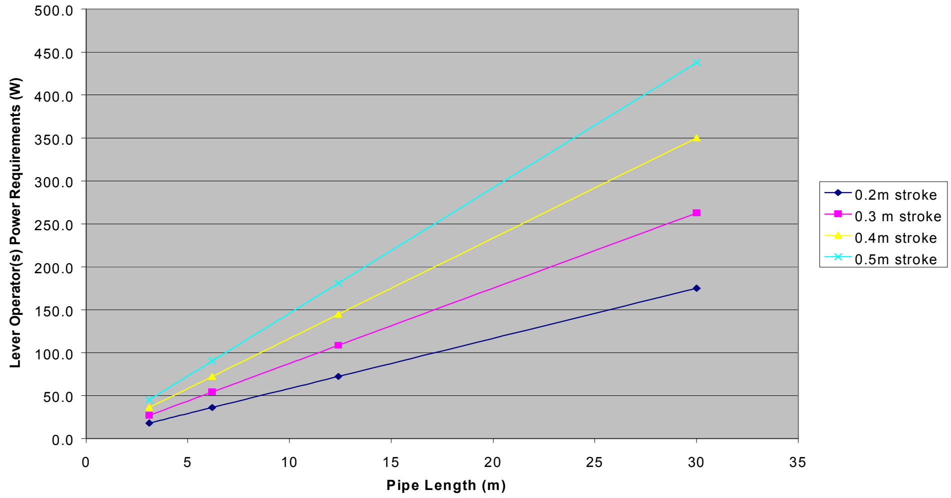

Figure 8: Power Requirements for Lever Operator when Drilling at 0.8 strokes/s

Figure 9: Mistry Squatting

Penetration Rates

The mean penetration rate for the well drilling observed was 21m/hr, with rates varying from 16.5 to 45m/hr, depending on the drilling conditions.

WELL COMPLETION

Cleaning

On completion of the drilling, the Mistri logs the hole depth and commences the cleaning process. The hole is washed by pouring clean water through the drillpipe into the hole and displacing the mucky drilling water. With clean water in the hole, the drillpipe is removed and the screen and casing are inserted.

Subsequently, more clean water is poured down into the casing and screen (Figure 10) and flows up the annulus, further washing fines and dirty water away from the screen. A head pan of sand removed from the hole during the drilling and washed clear of fines is used as a gravel pack and washed down the hole annulus.

Figure 10: Hole Cleaning

Casing and Screen

All casing and screens observed are low cost solutions. The cheapest version is a fabric covered bamboo based screen. The structure is constructed from between 7 and 9 split bamboo slats 10 to 20mm wide and 5mm thick (Figure 11). They are formed on to 20mm long "doughnuts" (Figures 12 and 13) of cut bamboo. The open latticed structure is tied with string or wire. A cloth covering of either white mosquito netting (Figure 14) or synthetic cloth is wrapped around the structure at least twice. This screen is manufactured on site by the Mistry and is included in the quoted drilling cost. The bamboo is obtained from the client's land, or nearby, resulting in the effective cost of the screen comprising only the string or wire and filter cloth. Such screen is said to last three years.

Figure 11: Cutting of Bamboo Slats

Figure 12: Cutting the Bamboo “Doughnuts”

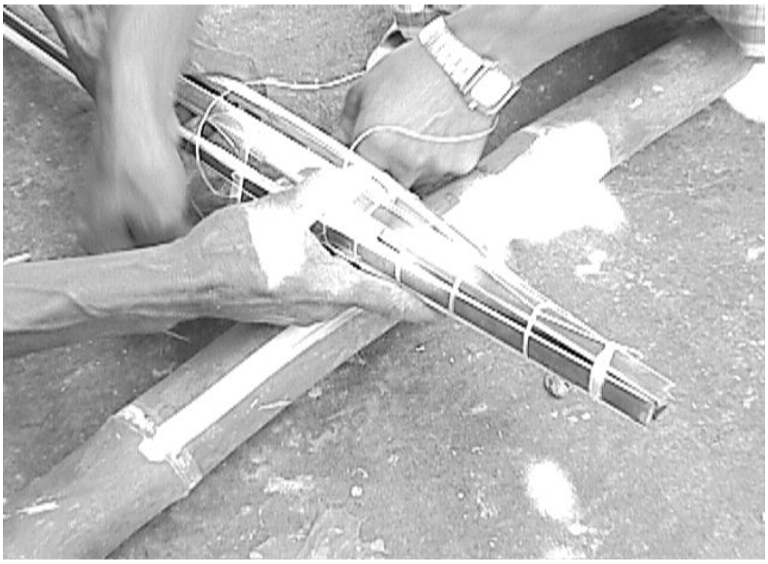

Figure 13: Bamboo Screen Construction

Figure 14: Bamboo Screen Structure and Netting

Alternatives are available in the hardware shops. 1½" galvanised pipes with large pressed out oval holes covered in fine brass mesh and brass sheet (Figure 15). This is mainly used for government funded No 6 Hand pumps installations.

Figure 15: Screen formed from Galvanised Pipe with Pressed out Holes Covered in Brass Sheet

Thin white polythene pipe 48mm OD 2.4mm wall is also available with machined pinholes of approximately 0.4mm diameter. There are 100 holes per circumference and 400 rows per metre. Note that conventional slotted PVC pipe is not in evidence.

Casing material is either PVC or Bamboo. The preferred species of bamboo is fast growing with a long distance between the knuckles and contains minimum pith. Bamboo of suitable diameter and length is cut, and the centre is cleaned with a steel, rhomboidal shaped flat face (Figure 16) which is fitted to a long ½" steel reinforcing bar and hand crank. The cleaning process is shown in Figure 17.

Figure 16: Bamboo Cleaning Tool

Figure 17: Cleaning the Pith out of the Bamboo

The bamboo lengths are joined by cutting sockets and allowing the bamboo to slip together. The casing is made leak proof by stretching a strip of old rubber inner tube over the joint.

All wells in the area are direct suction, with the pumps mounting directly onto the well casing. Thus conventional methods of dipping water levels during pumping would be difficult to achieve without installing dip tubes.

Figure 18 illustrates the flow from a 3” diesel pump which has been installed on to a sludged borehole.

Figure 18: Flow from an Installed 3" Diesel Pump

COST

In direct comparison with hand auger equipment, the cost of the sludging rig is minimal. The mistries mobilise on a pair of bicycles, and have no need for a tripod, lifting equipment or temporary casing. The most expensive part of the investment is the 1½" boring tubes.

In North India, sludging is a very low cost drilling method. A 12m hole with fabricated bamboo screen is a comfortable day's work for team of 2 costing the client 200 rupees (£3–4).

EQUIPMENT CAPABILITIES

The method is used to drill sands, silt and clay. No specific tooling is used or spoken of in order to deal with sticky clay, which apparently would be sludged up in small lumps and washed clear. There is plenty of evidence of local brick making and pottery in the area to assume that clay is present locally. The sludging method is not suitable for hard materials, and drilling is stopped whenever anything hard is encountered such as a hard layer, boulders or large gravel.

CONCLUSIONS AND IMPLICATIONS FOR THE LOW COST DRILLING PROJECT

The visit to Cooch Bihar indicates that Indian sludging is a very low cost drilling method which uses minimal equipment and is well entrenched into the private sector in North West Bengal. The technique as it stands is considered to be suitable for application to the soft formations in Uganda/Sub-Saharan Africa.

Observations of the sludging technique have illustrated a number of practical issues for the LCD technology.

- The cuttings can be successfully removed from the base of the hole with high flow rates up the drill pipe. The drill stem has a drive shoe attached to the base which fits closely to the inner surface of the borehole. It is likely that the fit of the shoe increases the flow up the drill pipe by restricting flow past in the annulus, thus forcing the water up into the drill pipe. In order to successfully utilise the sludging technique and obtain the required flow to remove the cuttings, the effect of the drill shoe should be analysed.

- The suction head is kept to a minimum by alternating between 1.5 and 3m pipe lengths at the surface. This may enable higher flowrates to be reached than sludging which uses 3m pipe lengths only. However, the main obvious advantage of alternating pipe lengths is the lack of need of a scaffold structure in order to reach the top of the pipe.

- The holes are kept flooded throughout the sludging process. The cost of this is borne by the client, who supplies the water throughout. The drilling observed took place just after the rainy season, when there are still sufficient quantities of pooled water which can be utilised. The question of supplier and water source in the context of Uganda/Sub-Saharan Africa needs to be analysed and addressed in collaboration with communities, farmers and contractors.

- The overall cost of the completed well in soft formations at £3-4 is very low. As well as low labour costs, and exclusion of the cost of fetching water, this also reflects the locally made, low cost screen and casing. In order to push down costs in Uganda/Sub-Saharan Africa, alternatives to traditional PVC screen and ready made casing should be investigated. Furthermore, it should be noted that as soon as rock is encountered, the penetration rate will be reduced considerably. This will increasing the drilling time and require stronger rock drilling tools.

- Measurements have shown approximate work output levels for the lever operator and illustrate the need for additional human power, or mechanical advantage as the drilling penetrates deeper into the ground.

- The restriction of the equipment to soft formations highlights the need to undertake further study and practical work in drilling through harder materials with this technique.

- The measurement of penetration rates achievable in Cooch Bihar provides a comparison for drilling in similar soft materials in Uganda.

Evaluation of Rapid Well Jetting
and the
Canzee Handpump

Annex 7.10

Ultra-rapid Well Construction

A Case Study on

Sustainability of a semi-household level post emergency intervention

A Case Study of Adriaan Mol, Eric Fewster, Kathryn Osborn, Madagascar

31st WEDC International Conference, Kampala, Uganda, 2005

MAXIMIZING THE BENEFITS FROM WATER AND ENVIRONMENTAL SANITATION

Ultra-rapid well construction: Sustainability of a semi-household level, post-emergency intervention

Adriaan Mol, Eric Fewster, Kathryn Osborn, Madagascar

When cyclone Gafilo hit Madagascar in March 2004, BushProof provided support to an emergency relief project implemented by international NGO Medair in the flood-hit region around the town of Maroantsetra. With wind speeds of over 300 kilometres per hour, whole villages had been destroyed, forests uprooted, bridges swept away and crops damaged. A deluge of rainfall caused massive flooding and most water sources became heavily contaminated with faecal matter. Immediately, several (household level) emergency actions were undertaken. To mitigate against future contamination of open water sources, BushProof pioneered a permanent solution through the very rapid construction of more than 200 new wells equipped with hand pumps, using an innovative well jetting technique. Thanks to its potential to rapidly reach large numbers of people in an affordable manner, jetting is now being integrated in ongoing development project.

Emergency response

In the flooded areas, rapid action was called for to avoid an epidemic because of the cross contamination between flooded latrines, open ground defecation and the many open wells. By helicopter, thousands bottles of Sûr'Eau chlorine solution were dropped near inundated villages that could not be reached otherwise[1]. Afraid to abandon their houses to thieves, people continued to literally live in the floods, drinking the contaminated water from the floods. Follow up visits by boat and the use of radio messages ensured that people knew how to use the product properly.

In the town of Maroantsetra itself water receded quite rapidly. A team of BushProof and Medair staff immediately implemented an open well disinfection campaign. In just over a week, some 1,400 private and public wells were disinfected using chlorine solution. However, during this time it became clear that most wells were very poorly constructed. Many were little more than dug-in rusty barrels and few had a head wall high enough to prevent floodwater entering. It was obvious that even under normal circumstances the water in these wells was highly susceptible to contamination: improvement was urgent.

Mitigation: bio-sand filtration in town

In town, the immediate emergency phase was quickly over and it was time to think about mitigation: actions that would minimize the impact of future cyclones and flooding[2]. Initially, Emergency Response NGO Medair decided to rehabilitate and improve a number of open public wells in town. This was done through local contractors, who repaired the wells, cast proper drainage platforms and flood-proofed the wells by raising the head wall above average flood levels. However, this could only serve relatively few people, given the high number of private wells in the town.

To address this, the NGO introduced household-level bio-sand filters[3]. Complete training was done to cover all aspects for a successful business – from construction and maintenance, to promotion and business planning. Although slow, there is a clear demand for the bio-sand filter from both within the town and the surrounding rural communities. The filters are sold at a 30% profit making it a sustainable part time business. These micro-enterprises have continued to produce and sell filters since the NGO left. On the other side of the island the same NGO sold

Box 1. Jetting explained

Jetting is a rapid method for well construction that works by flushing a well screen into a shallow aquifer. A PVC pipe, fitted with a special self-jetting well screen, is connected to a small motor pump. The jet of water from the end of the screen fluidizes the sandy soil and the pipe can be easily pushed down. In Madagascar, between 500 – 1000 litres of water are needed to jet a well to a depth between 5 and 8 meters. The amount needed can be minimised by starting to jet at the bottom of a hole dug down to the water table.

Once the screen has reached the desired depth (usually as deep as possible), a filter pack is inserted. This is done by gradually reducing the flow from the pump while pouring a mix of well graded sand down the hole. The upward flow of water continues to carry fine particles away, but the courser grains sink against the flow and settle around the well screen, thus forming a gravel pack. The well is then finished in a normal manner.

In practice, jetting is limited to a depth of about 8 metres and works well in unconsolidated sediments such as those found in alluvial areas. BushProof has obtained excellent results in recent emergencies, including Sudan (Darfur), Sri Lanka (tsunami) and Madagascar, where 200 new wells equipped with Canzee hand pumps were produced at a maximum rate of 50 per week. However, the technique is equally suitable for development situations.

more than 600 filters to cyclone victims. This reinforced the fact that it *is* possible to create sustained demand for the filters even in a post-emergency setting. The higher number so filters sold was probably due to a much stronger NGO

Photograph 1. It only takes about 2 minutes to jet a well screen 4-5 meters into the aquifer.

presence in this area. In both cases however, it is recommended to create a partnership with a dedicated developmental partner to continue support with marketing and quality control after the emergency NGO pulls out.

Mitigation: well jetting in villages

While the town dried up within some days, many villages remained inundated for weeks. Once the water receded it became clear that the 'normal' drinking water situation was much worse than in town. Hand dug wells of any kind were virtually non-existent and many people took their water directly from rivers, ponds or rice fields. Nobody used latrines: open defecation was practised, ironically often near traditional water sources.

BushProof therefore developed a radical concept which would serve their long-term water needs while making use of available short-term emergency funding: extremely rapid well construction at semi-household level. By adapting well jetting, a well-known but little used technique, over 200 wells were constructed within a very short time – sometimes at a rate of 50 per week. Due to the very low cost of jetted water points, a high density of pumps per head of population could be achieved. This allowed the project to work at *semi-household level*, by constructing one well for every family / neighbour group, made up of 5 - 10 neighbouring households clustered closely together. Several reasons were important in the decision to work on household level: improved ownership and sustainability, longer lifespan of the pump (less intensive use), convenience and the health benefits of having larger quantities of water close at home.

Choice of pump

Each well was equipped with a Canzee hand pump to ensure a high standard of water quality. The choice for this pump was based on its ingenious simplicity: it has no conventional piston or seals. The pump contains no significantly wearing parts and needs no maintenance. The few parts that can eventually break down are very easily repaired, using parts that can be made by the pump users themselves. Ideal for installation on shallow wells, the Canzee is robustly constructed and lifts water from at least 10 meters. In Madagascar, the Canzee is the only available low-lift hand pump that can be installed on jetted wells[5].

Community participation process

Despite a very fast approach in a post-emergency setting, the project contained significant beneficiary participation. The sequence of events started with FM radio announcements and letters to the village authorities, providing global information on the project. This was followed rapidly by a visit of a team of socio-organisers. During a village meeting, they explained the project opportunity in detail and what would be required in terms of participation. This discussion was immediately followed by the construction of a sample well. This gave the villagers the opportunity to see the jetting process and actually try out the well and hand pump on offer.

Photograph 2. The pump is installed by the well users themselves.

Based on the number of wells available per village (1 well for 100 people) the villagers were encouraged to join up with their neighbours and form well user groups. This automatically ensured the formation of strong groups made up of people that actually get along with each other. Each group then submitted an official request for a well during a final village meeting. Here, a large village map was drawn on the ground. The map showed major paths, rivers and houses. A representative from each prospective well user group then came forward and placed a mark (coconut shell or piece if wood) on the map, to indicate where they wanted a new well built. These requests were then compared with the actual number available to the village. If there was a difference, the villagers discussed among themselves which groups were close enough to share one water point between them. This continued until an agreement was reached that both the village and the project were happy with. This discussion process was particularly valuable for increasing the ownership and value placed on each pump.

Obscure arrangements…?

At the end of the meeting an agreement was signed between the NGO and the local authorities. This confirmed the number of pumps available to the village, their locations and outlined the responsibilities of the villagers. These included the collection of gravel, sand and clay (for grouting the well pipe). In terms of labour, the villages provided two people to help build the concrete pump foundation. Furthermore, they would also dig a 1000 litre reservoir lined with a tarpaulin and fill it with water needed to jet. Finally, they would dig a second hole all the way down to the water table at the exact site of the new well (usually between 1 and 4 meters deep). A clear deadline was set by which the sand, gravel and hole was to be completed: often the whole process from first contact to the start of construction lasted no more than 1 week.

While construction of the wells was going on, each well user group nominated 2 members for a village water committee. These people were directly involved with the well construction and pump installation. A basic training course was given in how the pump worked, during which the committee members actually installed their own pump themselves, including gluing the joints, cutting rubber replacement discs for the valves, and the final installation. This increased ownership and provided a deeper understanding on how the pump worked.

The open process also provided absolute transparency between the stakeholders. In one village, the local mayor approached the project staff and asked for a well near his house. This request could be politely rejected because the whole community had already agreed on the well locations. There was no room 'on the side' for obscure arrangements!

Mistrust towards NGOs

Before the project gained momentum, it became apparent that there was a lot of mistrust from the side of villagers towards NGOs. Often they doubted that promises made would result in concrete benefits. As a result, their motivation to provide participation was initially very low. This was a problem, because project funding would be available for a few months only. The NGO therefore decided to place 'organisers' in each village for one full week prior to the start of construction. By simply observing a dedicated NGO presence in the village, the people were inspired with the trust needed to complete the agreed participation. On arrival, the organisers would often find no more than 20% of sand and gravel prepared. However, within 24 hours of their presence this usually increased to more than 80%. This illustrated that poor participation was not due to the lack of motivation, but a disbelief that the project would be realised as promised. Most likely, this was based on negative experiences with other NGOs that often conduct endless participatory meetings, create village groups and gather baseline data, without following up quickly with concrete action.

Due to the speedy process adopted by this project – whereby all wells were constructed within 2-3 weeks – the aid organisation quickly earned the nickname 'NGO No Blabla', which was taken as quite a compliment. It showed also that quality participatory processes do not necessarily have to take a lot of time.

Photograph 3. A life saved? If conditions are right, jetting will provide safe water faster and more affordable than other techniques.

Long-term sustainability

The project proved very successful. Within three months only, 204 new wells were installed in numerous villages. The extreme rapidity of the project, the deceptive simplicity of constructing jetted wells and the user-friendliness of the Canzee hand pump made headlines in

Madagascar. The project was visited by many people, including top government officials, donors and other NGOs. Because of the surprising cost-efficiency of the project, other NGOs have now contracted BushProof for the installation of jetted wells in their project areas as part of ongoing developmental project. The fact that the same budget is likely to produce 3-10 times more wells than using more conventional well construction techniques, makes jetting an attractive option. At the same time, such NGOs have more time available to work with the communities.

To facilitate for even better savings and to cater for growing demand, BushProof is now moving the production of the Canzee pump from the UK to Madagascar. This will lower the cost even further, making affordable, household-level hand pumps widely available in the country. This will also make it much easier to obtain replacement pumps, further increasing the sustainability of jetted wells.

Potential for scaling up

In conclusion, jetting and Canzee pumps have proved to be a successful and very cost-efficient mitigation action, and the technique has become integrated in the national water sector with hundreds of additional wells under construction. The cost of a completed water point (inclusive of apron and Canzee hand pump) averages between 600 and 800 Euros, depending on the numbers constructed and accessibility of the project area.. It takes no more than 2 working days for a team of locally recruited jetters, masons and pump installation teams to complete a well, but this time is spread over several days due to need to let the concrete slab harden. Using several teams, it is entirely feasible to construct between 5 and 10 wells every day over longer periods of time.

Outside Madagascar, BushProof was able to introduce jetting also in other emergencies, such as Darfur (Sudan) and more recently in Sri Lanka after the tsunami, but the potential of the technique is only just emerging. It will be worthwhile to explore in which other regions jetting can be applied, especially in a development setting. In combination with a fast project methodology, it is now possible to provide very large numbers of people with safe drinking water very quickly, even on a household level. This makes it possible to make a significant contribution towards achieving the Millennium Development Goals for Water, at a minimal cost. While the technique is not suited for all areas, in Madagascar alone over one million people could benefit from jetted wells equipped with low-cost pumps.

References

Note/s

1. Sûr'Eau is a Safe Water chlorine solution for household water treatment. It is marketed by PSI and is widely available in Madagascar.
2. Madagascar is very vulnerable to cyclones. Every year, the island is hit by several storms, although not all are of the same magnitude as Gafilo.
3. A wealth of information on bio-sand filtration can be found on www.biosandfilter.org.
4. Medair also introduced bio-sand filters on the west coast in another cyclone-hit area. Here, more than 600 filters were constructed and successfully installed at individual households in a number of villages.
5. The NGO Taratra produces a good quality rope-washer pump. However, their workshop is located deep in the bush and pumps are difficult to obtain especially in large numbers. The pump is also more expensive than the Canzee and cannot be installed in the narrow-diameter jetted wells. More information on the Canzee pump is available at www.canzee.com.

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